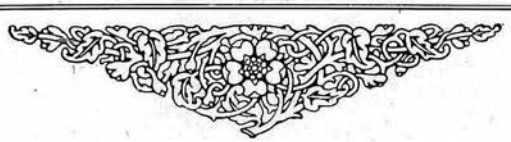
A series of articles describing the Manufacture of Braid in the United States,

appeared in the TEXTILE WORLD RECORD, of Boston, Mass., during 1907 and 1908.

Numerous requests have been received by us from our customers for copies of these articles, and it is in order to accommodate the demands for information as to the uses to which the various machines we manufacture are put that we concluded to publish these articles in pamphlet form.



October, 1909

TEXTILE MACHINE WORKS

F. THUN, Sec'y-Treas.

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'HE MANUFACTURE OF BRAID IN THE UNITED STATES

By Ferdinand Thun

(First published in the TEXTILE WORLD RECORD.)

n some of the previous issues of this jour-, a series of articles have been published, ıtingon the manufacture of braids. These icles were translated from a German book ich appeared about ten years ago, and,

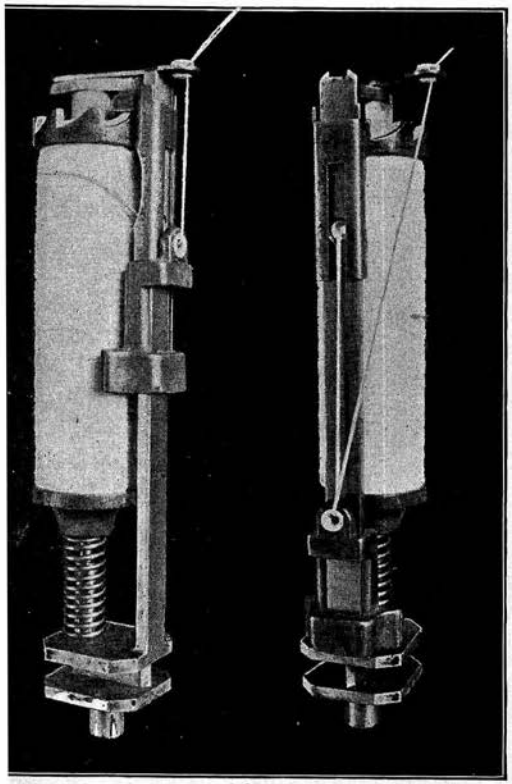


Fig. 1

le they are very instructive and interest- owing to the fact that they go into the ıry of the construction of braids, yet, the elopment of this industry during the last years has been so rapid that most of the ier machines are today of obsolete type. the following pages will be given a de- ption of some of the high grade braiding machinery produced by the Textile Machine Works, Incorporated, of Reading, Pa. This firm has been largely instrumental in building up the braid industry of this country, by combining a thorough knowledge of this industry and its requirements with high grade mechanical talent. That these qualifications created new types of machines in a modern machine shop filled with labor saving machinery and employing over 300 mechanics was a natural result.

The mechanical construction of braiding machines as built by the Textile Machine Works, follows in all essential details the German type. The experience of a century of braiding machine construction is made use of in the selection of materials and in construction. Rolled steel is used for the top and bottom plates. The gears are cut and have long bushings exactly like the Barmen type. The gear bolts are made on automatic machinery from open hearth steel and have squares milled on both ends. The carrier is generally of the square pipe type, with inside weights, known as the German carrier, but, for special purposes, a carrier with outside weights is frequently employed, as shown in Fig. 1. This patented carrier offers the advantage that the bobbin can be very easily removed and replenished, while the threading is a very simple operation.

One great improvement introduced by the Textile Machine Works consists in making all their standard braiders with top plates of uniform thickness. This allows all spindles to be made interchangeable, as they all are of the same gauge. In a large braid factory this is of great importance.

The usual manner of operating braiders in a modern braid factory is by a gear drive. For this purpose a driving table, as illustrated in Fig. 2, is employed with a shaft 1½ inches in diameter extending through the entire length. The driving gears are so arranged that they can be fastened anywhere along the length of the driving table to suit the diameter of the machines. A box furnishes the bearing for the shaft and also the support for the upright spindle. A bevel

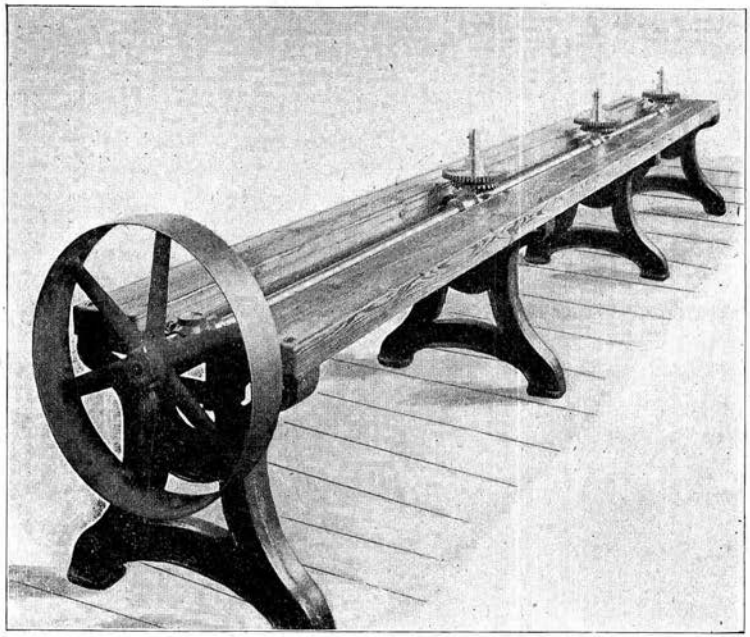


Fig. 2

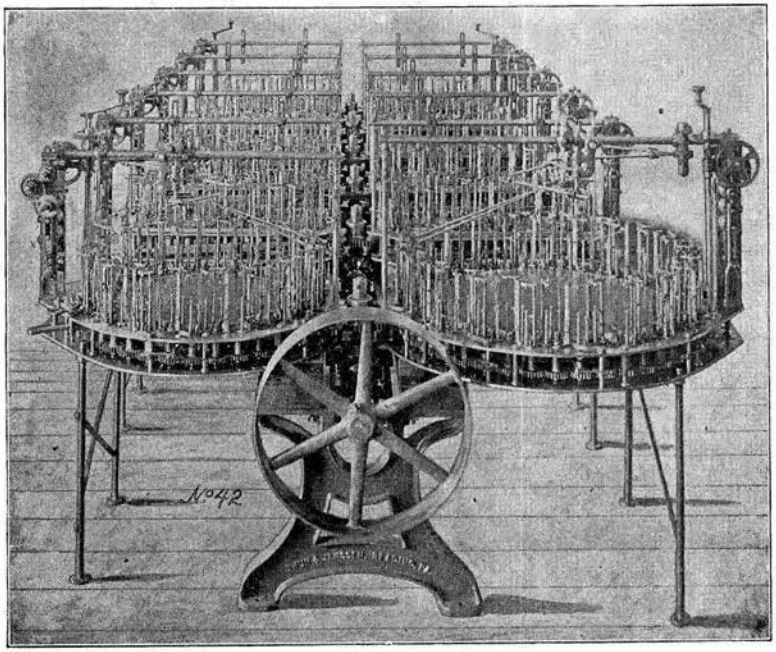


Fig. 3

gear is keyed on the shaft. Another bevel gear is set at right angles to the shaft, rotating on the upright spindle. There is a driving gear fastened adjustably to the bushing of the vertical bevel gear. Each of these driving gears can operate two machines, one on each side of the driving table. In Fi one of these driving tables is shown w braiders mounted on each side. This affo a very compact arrangement for locating driving the machines. It has the further vantage that there is no slipping of sp

ts and that the speed of each individual chine can be readily changed to suit the terial that is being worked, by simply nging one gear. This gear is a movable tch gear, in mesh with the spur gear on driving table. These clutch gears are nished with 14, 16, 18, 20, 22, 24 or 26 th. The speed of the braider is in direct portion to the number of teeth of these rs. The stop motion, which stops the ma- ne whenever a thread breaks or a spool is out, forces this clutch gear out of en-

a weave over one, under one.

3. Machines for making cords and tubular braids, consisting of two complete carrier courses crossing each other, and producing a round or hollow fabric.

4. Hercules braiders.

5. Stripe braiders.

6. Lace braiders.

7. Bi-circle or radium braiders.

All of these have several sub-classes according to the uses for which the product of the machines is intended. We will describe

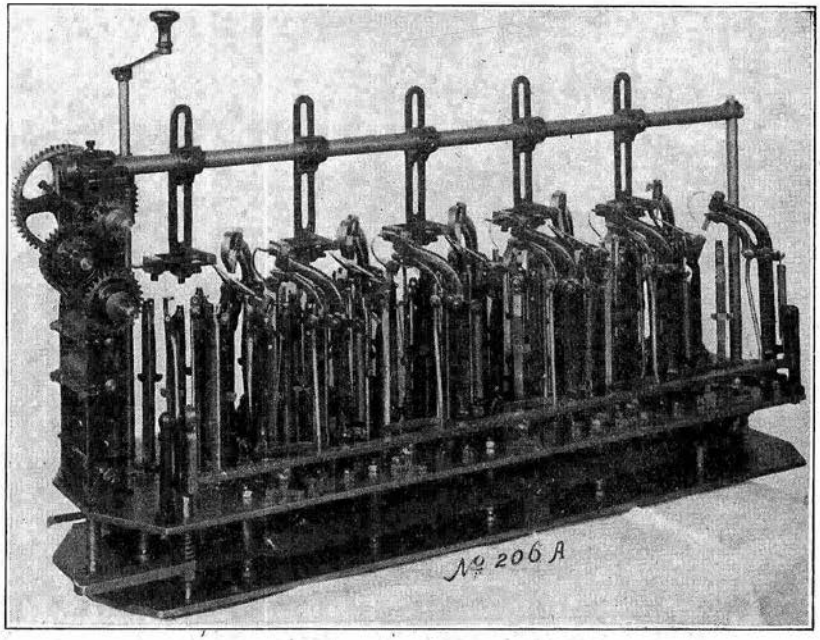


Fig. 4

gement with the lower driving gear in the chine by releasing a catch which holds clutch gear in operative position as long all tension weights in the spindles are sus- nded by the threads during the braiding eration. This principle is common to all pes of braiding machines.

According to the class of braids to be nufactured, braiding machines may be bdivided as follows:

1. Machines for making plain, flat braid, ring the threads under two, over two.

2. Diamond braiders, of the same general nstruction, except that the terminal gears e six horn, and the resulting fabric shows

a few characteristic types of braiding machines.

Fig. 4 shows a 5-head, 9-carrier machine provided with loop attachments. This machine produces five strips of the narrowest flat braid made, each braid consisting of nine strands. By means of the loop attachments, a loop or feather edge is provided.

Fig. 5 illustrates this loop attachment in detail. It consists of an inner and outer post adapted to throw a sliding dog or collar, a, alternately to the inside and outside of the braiding threads. The side view shows the dog in the position outside of the braiding threads. To the eyelet shown on the left

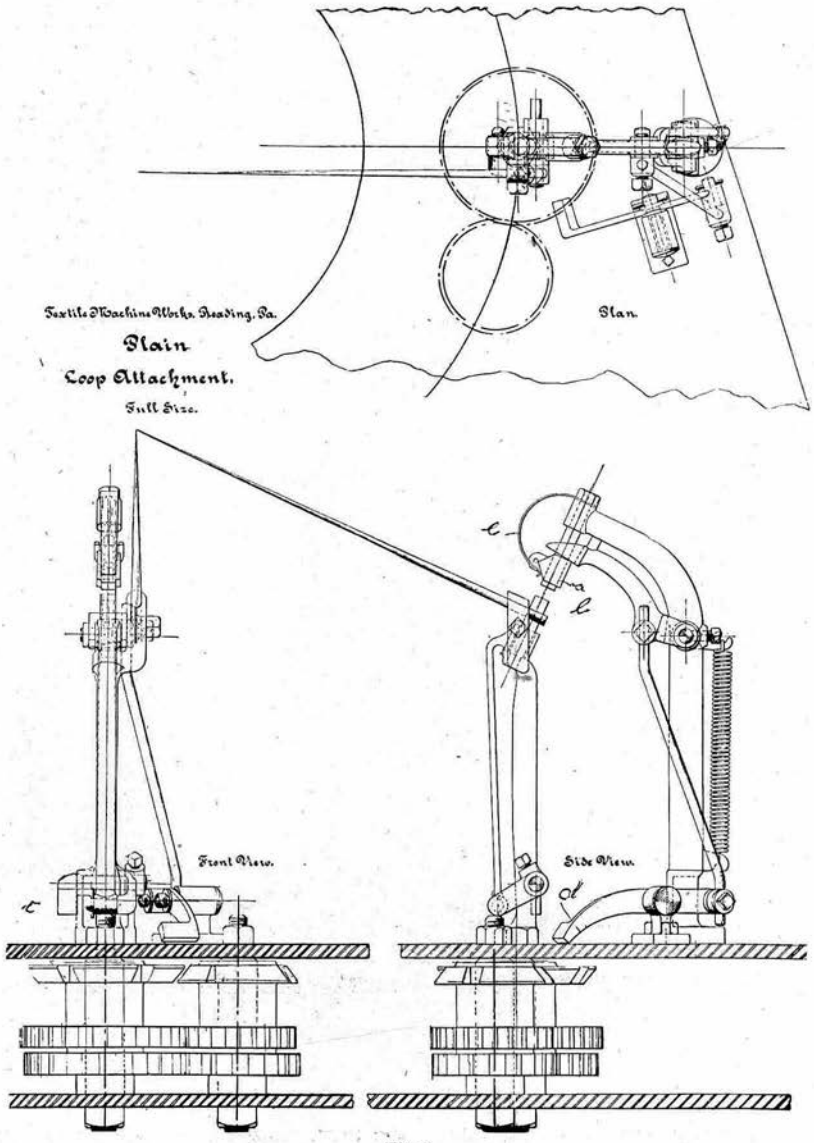


Fig. 5

of the dog, a wire or, in some cases, a bunch of horse hair or other pliable material is attached. By the thickness of this, the size of the loops is regulated. The inner post is fastened on the terminal gear of the braiding machine, and it is clear that all the threads of a flat braid must pass over a wire attached to the sliding collar, when this collar is on the square projection, b, forming the uppermost end of the inner post. The bell-crank lever attached to this inner post or standard serves to throw the sliding collar upward, whenever a suitable shoe fa ened on the braiding carrier strikes the p jecting end of the bell-crank lever shown the left hand side of the front view. T outer post or standard is also provided wi a similar lever mechanism. Suitable colla or shoes on the carriers striking the end the horizontal member, d, of the outer lev mechanism impart a blow to the sliding c lar and throw it back to its position on t inner post, the spiral spring serving to p back instantly the upper arm after it h

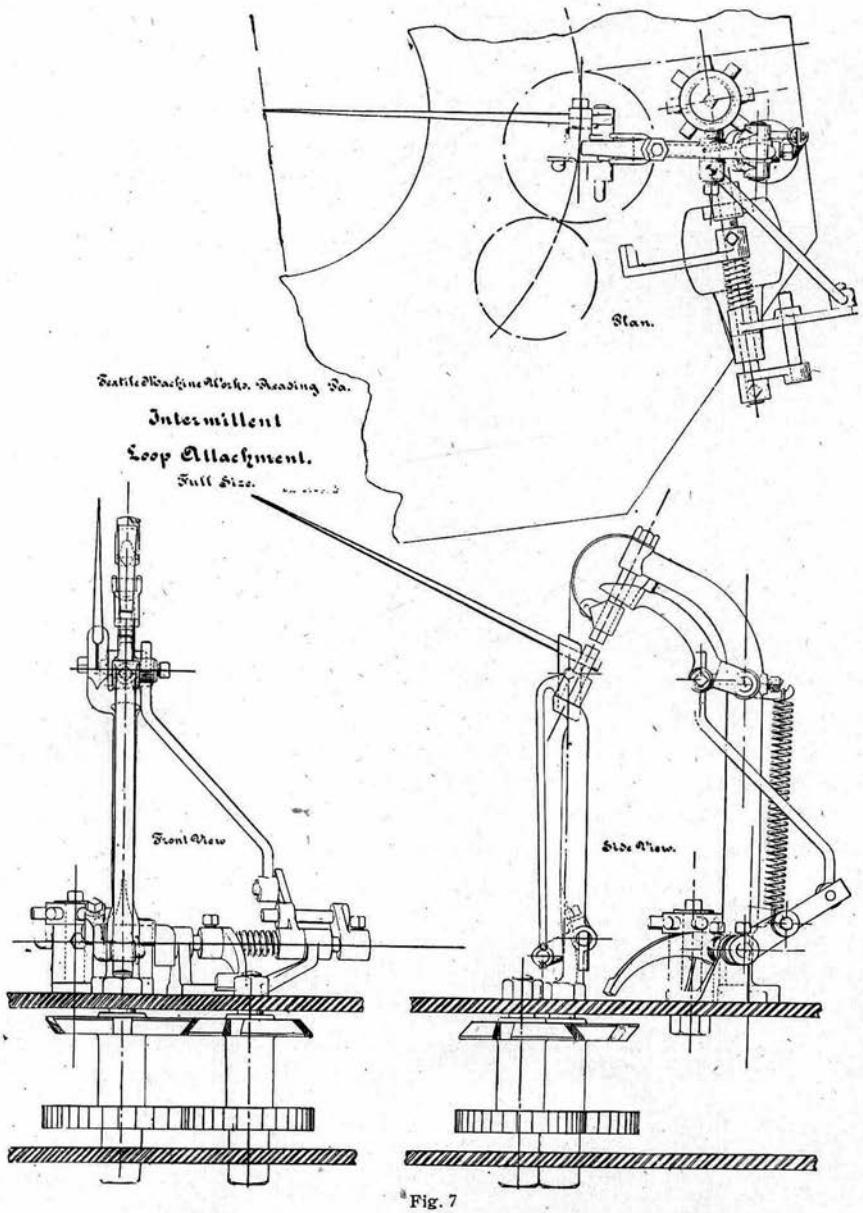
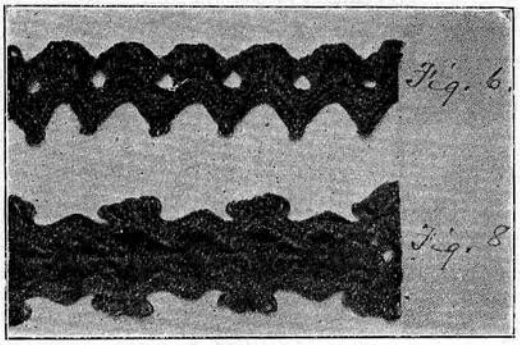


Fig. 7

pushed down the sliding collar. The curved spring, e, holds the sliding collar in place on the outer post until another carrier having a suitable shoe forces it down by means of the lever mechanism.

The braid, Fig. 6, shows the effects produced by the loop attachment. The broad feather edge shown on one side of the waved braid is produced by having six succesive carriers pass over the wires of the loop attachment when the sliding collar with the wires is held on the inner post. The remaining three carriers passing under the wires when the collar is on the outer post form a plain edge between the feather edge. The opposite side of the braid shows only a small loop for every ninth carrier. This means that on the other terminal only one carrier of the entire series passes over the wires of the loop attachment. This pattern also shows the effect of uneven weights in producing a zigzag or wave effect.



Figs. 6 and 8

Fig. 7 shows the intermittent loop attachment. This device is sometimes used to interrupt the regular rotation of the loops on a braided fabric, and to make the action of the shoes on the carriers inoperative during portions of the length of the braid. This is done by means of the turret, t, shown on the upper plan view of the drawing, and which acts upon the pawl of the outer standard and removes the same from operative position until such time as it is desired to have the regular operation of the loop attachment resumed.

Fig. 8 shows the effect produced by the intermittent loop attachment. This braid has the feather edge only on every second scallop, the intermediate ones being made with a plain edge by throwing the loop attachment out of action. This braid is made on a special type of stripe braiders, which will be illustrated later.

Fig. 9 shows a braiding machine of improved construction, used for making ordinary tubular shoe laces. It is mounted on long legs with a belt attachment. The most important feature is the patented carrier, which is operated without top weights. The tension weight slides on the outside standard

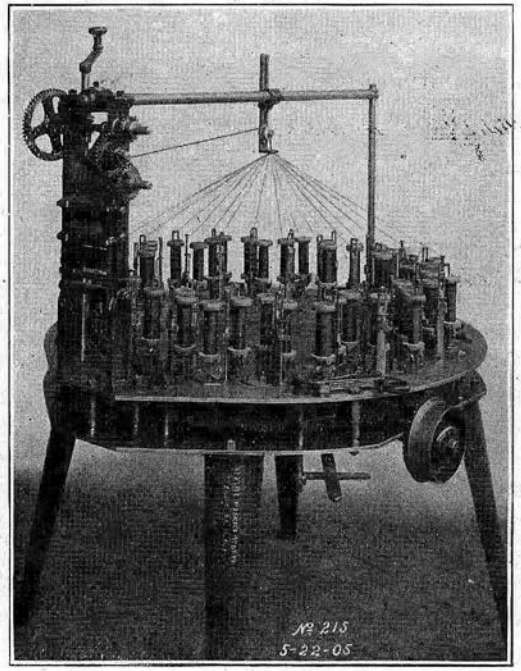


Fig. 9

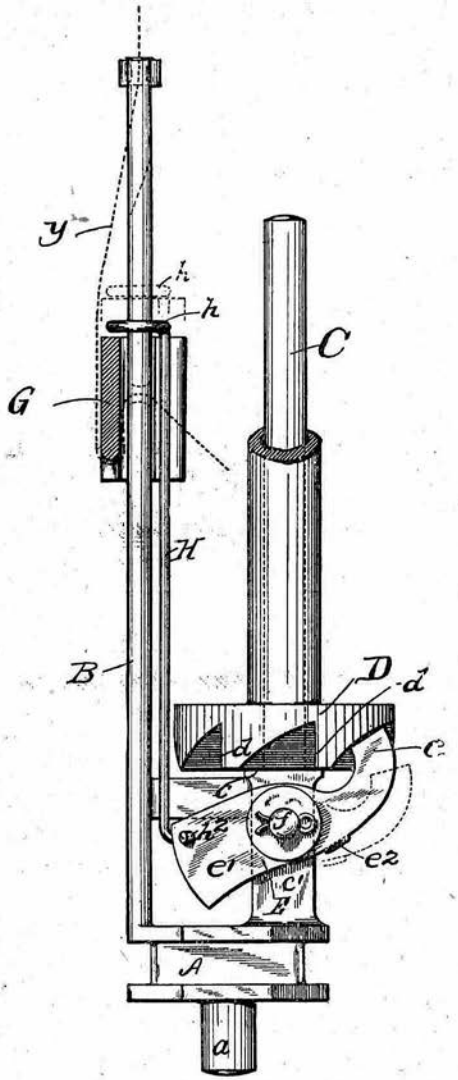


Fig. 10

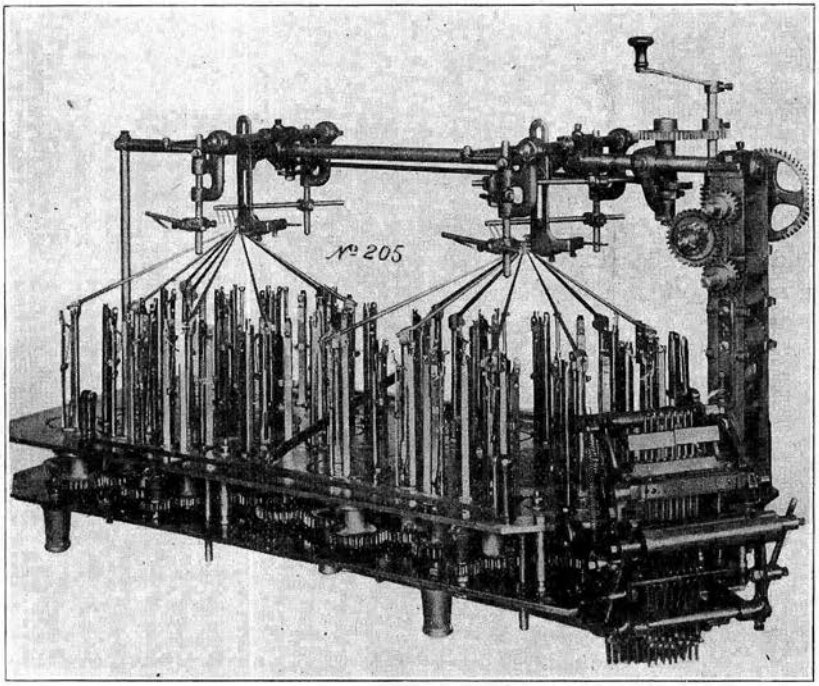


Fig. 11

ıd lets off the thread by striking against a ire projection attached to a pawl lever at ıe base of the carrier. This is so arranged ıat the ratchet head of the bobbin is pre- ınted from rotating until released. These ırriers, which are very simple and easy to read, have been a great success for plain aple articles, such as shoe laces, braided pes and for braiding around electrical ires. Fig. 10 will illustrate more clearly e special features of this carrier. One of s advantages is that "universal wound" bes can be readily used with it by using a ɔoden tube holder, D, instead of the usual ɔbbin with two heads. Both tube holders ıd bobbins can be used on these carriers in- rchangeably.

Fig. 11 shows a 2-head, 25-carrier braid- g machine for making 6-line flat braids ith irregular loop edges. Instead of the op attachment already described, a side ack course is built into the machine and rms an auxiliary terminal. Switches allow guiding the carriers either around the or- nary terminals or the auxiliaries. These switches are operated by a jacquard mechanism, shown on the left of the take-up roller stand, and which will be more fully described in connection with other braiders later on. A great variety of loop edge fabrics can be made by means of these side tracks and the jacquard head. The side track terminals in this case are provided with selvage needles projecting into the braid former.

Fig. 12 shows a plain braider, used for a special purpose. It has gears of large diameter and a special carrier adapted for braiding wide straw, whence it is ordinarily known as a "straw braider." Fig. 13 shows the product of this machine. The straw or strip from which this braid is made is an artificial product produced by gluing together threads of tussah silk. This silk has a high lustre and can be dyed in any colors. The operation of gluing the strip is simple and rapid if suitable machines are employed. This material, together with artificial horse hair and artificial silk, made into braids of varied designs on suitable machinery con-

structed for that purpose, has revolutionized the millinery business during the last ten years.

Fig. 14 shows another straw braider with a special side track terminal for producing fancy loop edges on a plain straw braider. A disc jacquard is employed to govern the movement of the switch which guides the carriers around either the auxiliary or the regular terminal. A great many millinery braids are also produced on plain braiders, generally from artificial silk or peroxoline

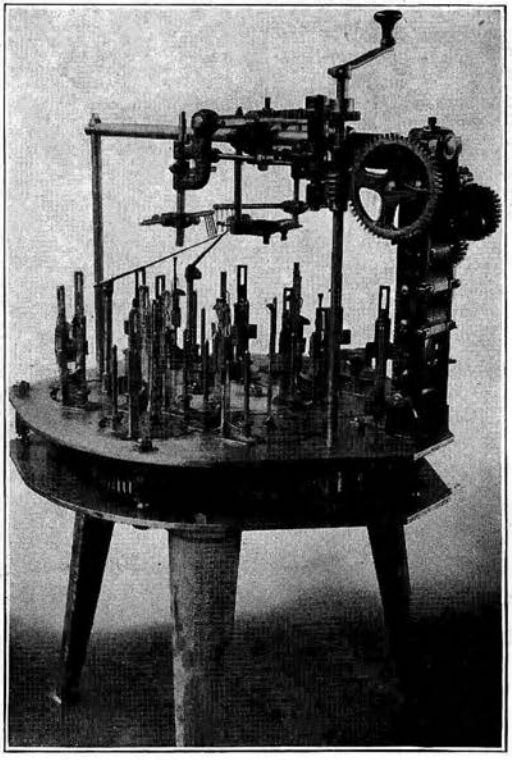


Fig. 12

(artificial horse hair). The samples shown at Fig. 15 ilustrate the capacity of the plain braider for producing fancy effects in millinery braids. The most suitable machines for this class of work are: 8-line (33-carrier); 10-line (41-carrier); 12-line (49-carrier) and 16-line (65-carrier).

The machines for making plain braids always consist of an even number of gears, of which all except the two end ones are four horn gears. The end gears or terminals are

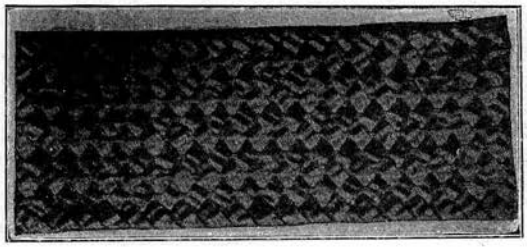


Fig. 13

provided with five horns. As a result the number of threads in a plain braid always equals a multiple of four plus one, thus: nine, thirteen, seventeen, twenty-one, twenty-five, etc. The lay of the threads is over two, under two.

The same braiders can also be used for "diamond" braids by a suitable provision for changing the terminal gears. Various patented improvements have been designed to make such a change from plain to diamond, the most important of which is known as universal terminal change gears, now furnished by the Textile Machine Works, Reading, Pa. Braiding machines embodying this improvement are provided with end gears of a special construction. The terminals are of a diameter between those of a 5-horn and 6-

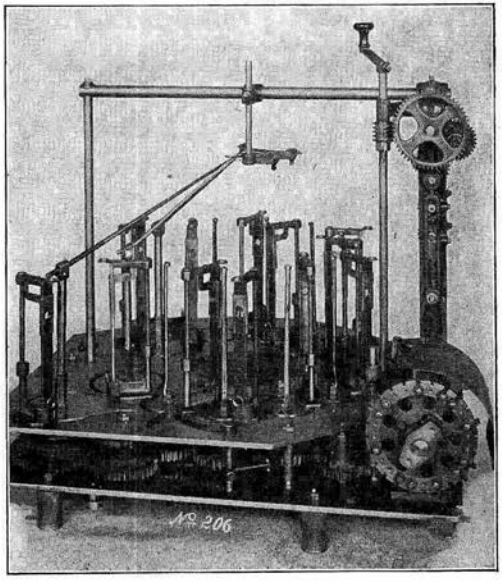


Fig. 14

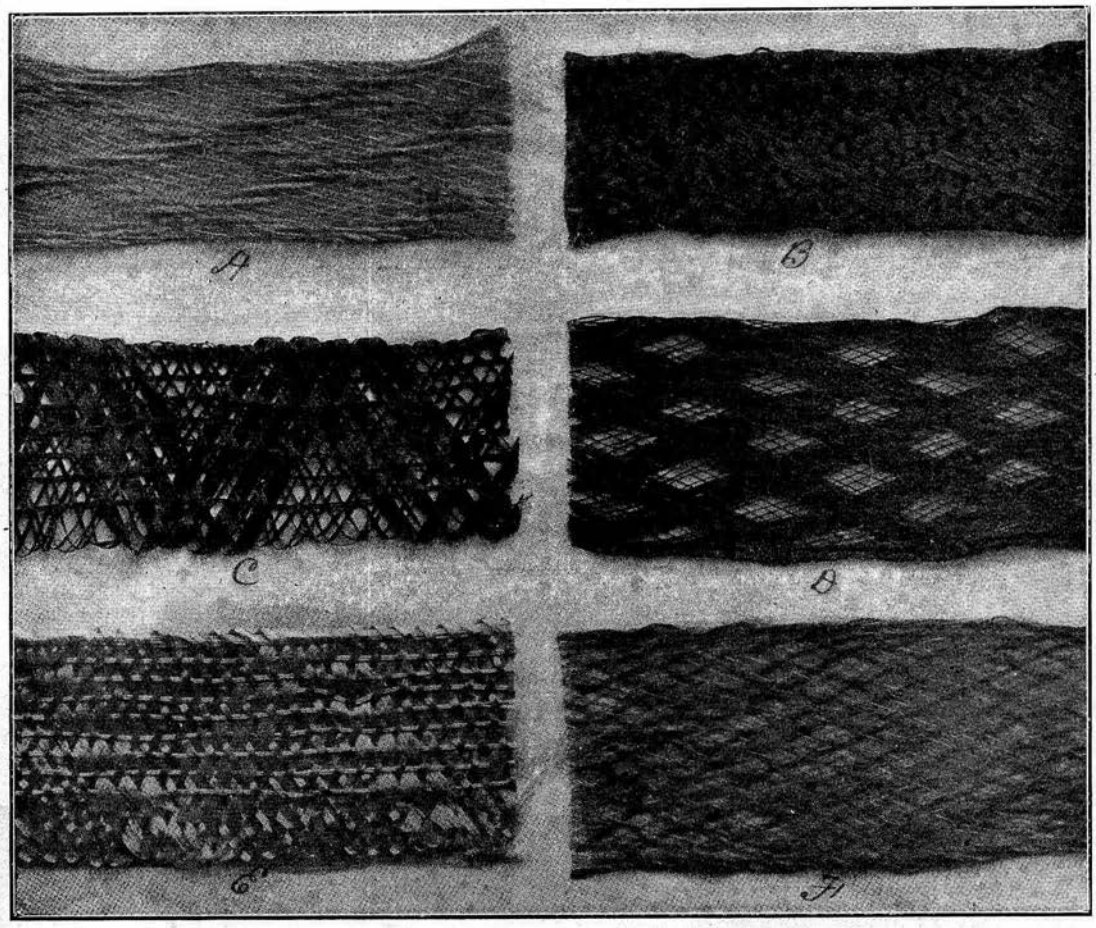
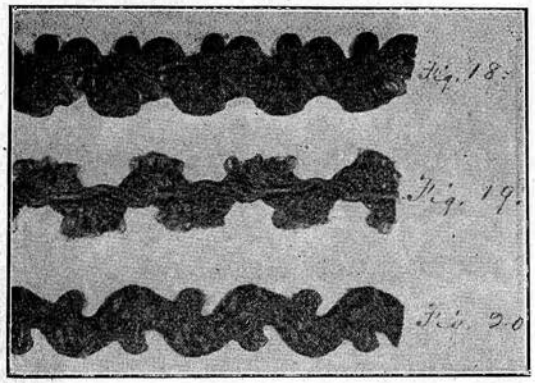


Fig. 15

horn gear. The 5- and 6-horn terminal gears used have the same dimensions, the difference consisting only in the number of horns and teeth. Since the diameters of the 5- and 6-horn gears are the same, the carriers remain in the same race way, no matter whether the machine runs as diamond or plain, and the only thing necessary to make the change is to unscrew the bottom end of the gear bolt, lift out the bolt, disc and needle post all in one, as shown at Fig. 17, then replace the end gears by the ones required, as indicated in Figs. 16 and 17, and set up the carriers in the order required for the respective braid.

The machines may be changed to 3-horn in the same manner, by replacing one of the end gears by a 3-horn gear. In this case, however, it is necessary to provide a special driving gear next to the 3-horn terminal, which will drive the horn gears at the ratio of four to three. This special driving gear can remain in the machine so that in fact either 5-, 6- or 3-horn terminals can be put in by replacing the end gears only. The advantage of this simple change of terminals is enormous, as it increases considerably the pattern possibilities of the machines. The main advantage of this change over former contrivances lies in the fact that these gears can be interchangeably used on braiders from 6-line to 24-line, and that it is not necessary to have special gears for special machines, or to have them fitted in when the machines are built.

Having thus briefly described the main



Figs. 18, 19, 20

features of up-to-date flat braiders, we will call attention to a few more characteristic patterns.

Fig. 18 is a four-line waved braid, made with uneven weights to produce the zigzag effect, and with a loop attachment on both terminals. The gimp that forms the one loop is previously made on a gimp machine, and must be of the required twist and pliability. It is placed on a braider bobbin and braided in like the other threads, and the loop is produced by the looper already described.

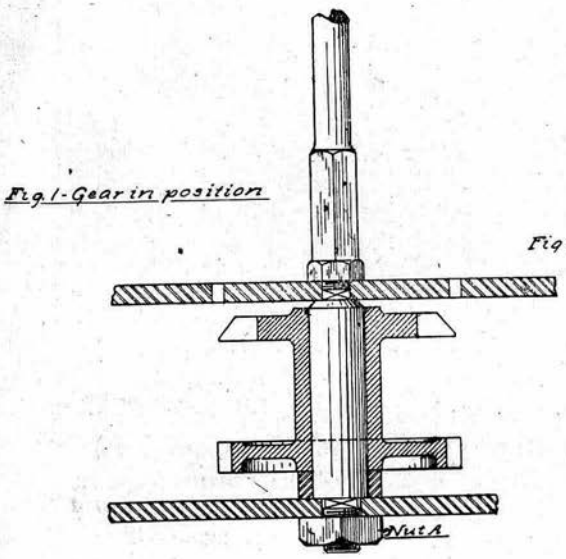


Fig. 16

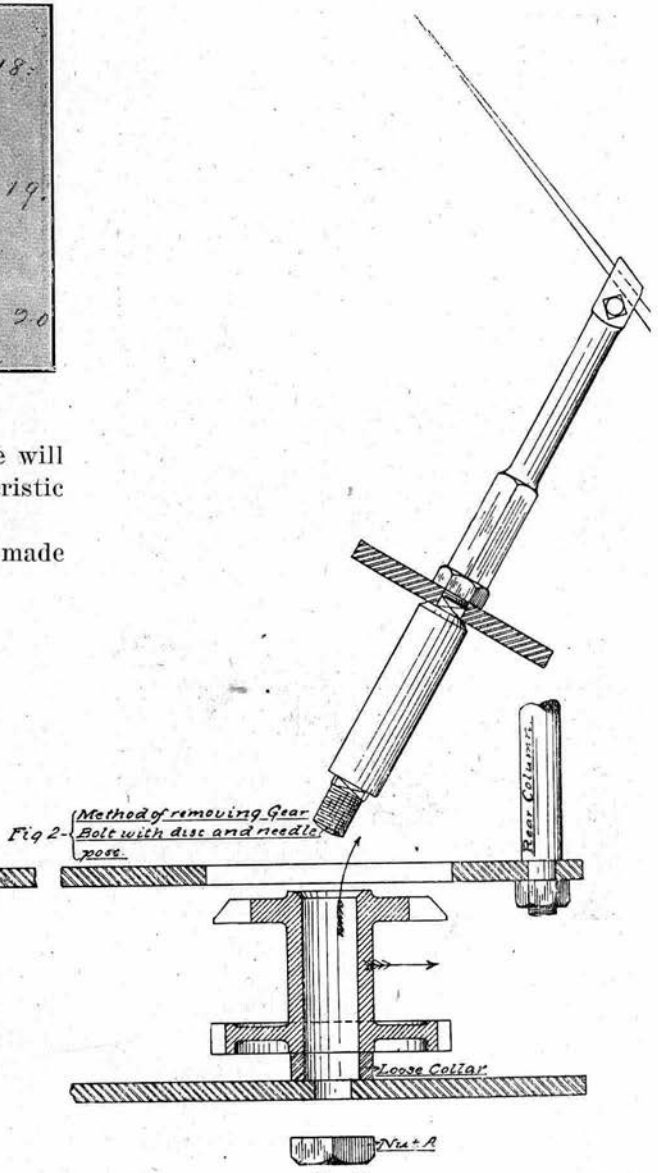
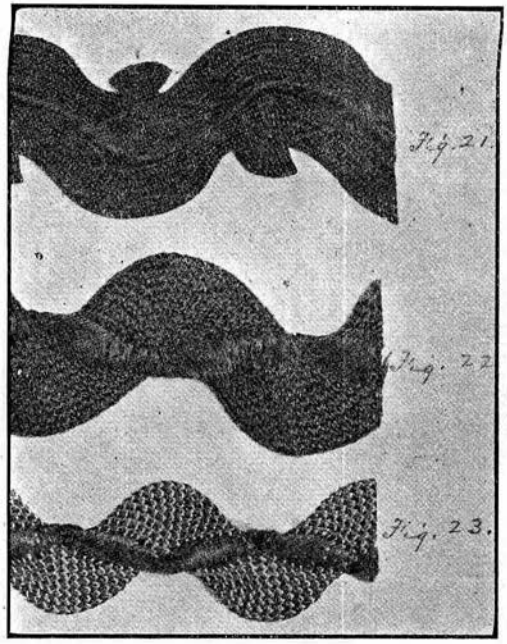


Fig. 17

The braid pattern shown at Fig. 19 is made on a 25-carrier braider by using a loop attachment on both sides, and by letting some of the carriers run empty. One of the carriers braids a gimp which is laid into the centre of the braid and thoroughly covered by the other silk threads, this pattern being very tightly braided.

The braid at Fig. 20 is made on 25-carrier, 6-line plain braiders, and the peculiar double scalloped effect is produced by uneven weights which form practically one narrow zigzag braid running through the main

wave braid. The formation of this braid is assisted by a suitable bending of the selvage needles in the former.



Figs. 21, 22, 23

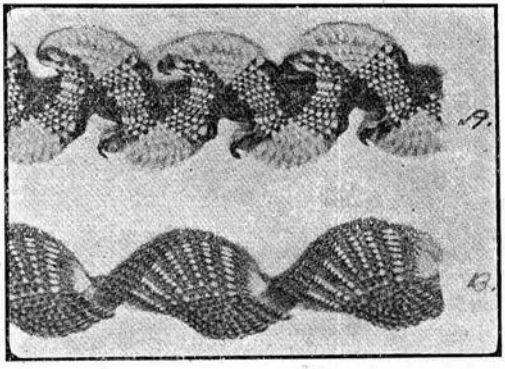


Fig. 24

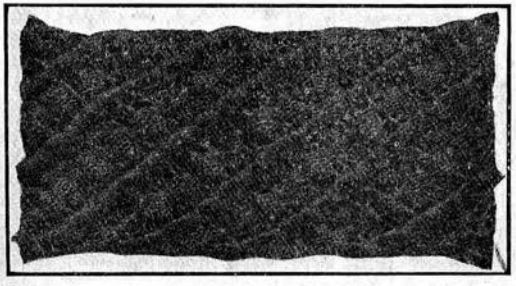


Fig. 25

Braid pattern No. 21 is a large wave-braid, made on a 65-carrier, 16-line, plain braider. The broad satin rib in the centre is produced by a soft cotton warp thread introduced through the warp guides. This warp thread follows the contours of the braid, as it always remains in the centre of the fabric. The braid is set very tightly so that the warp thread is completely covered. The other heavy rib running transversely through the braid is produced by braiding in an 8-line

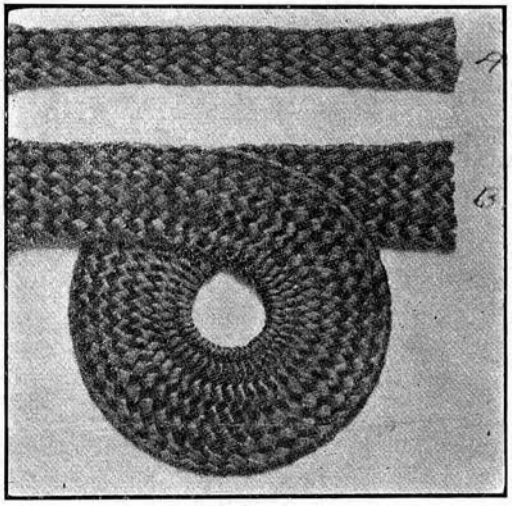


Fig. 26

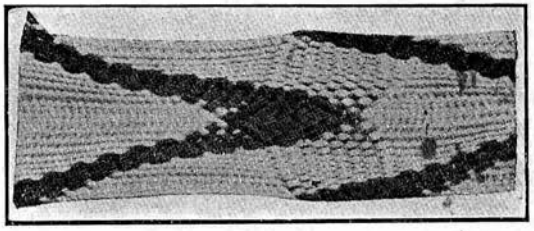


Fig. 27

silk braid. This braid is formed into a loop by a looper on each terminal.

The braid pattern shown at Fig. 22 is made on a 12-line, plain braider with a 3-horn terminal. The heavy rib in the centre is produced by a bulky soft thread being braided in and overlaid by silk threads interbraiding with the same. The peculiar appearance of the braid is obtained by alternately heavy and light silk, thus: running five ends on one spool and two ends on the

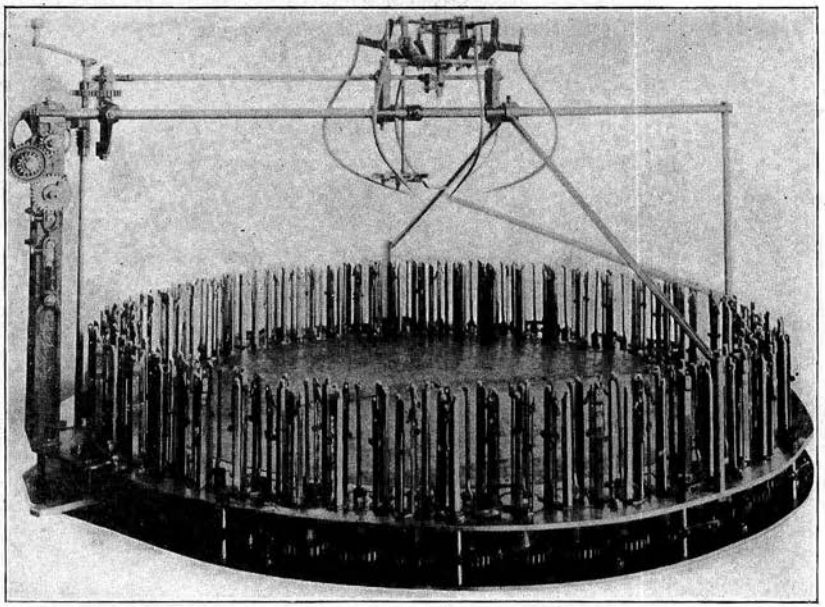


Fig. 28

next, and continuing this on the entire machine.

Fig. 23 is similar to Fig. 22 and is made on a 9-line plain braider with a 3-horn terminal. Instead of heavy and light threads, as in Fig. 22, two contrasting colors are used, to produce a peculiar mixed effect.

Fig. 24 shows additional fancy effects produced by the combined use of uneven tension weights, gimps and the loop attachment. Both of these patterns show a diamond weave, the threads lying over one under one. They are produced by using 6-horn terminals.

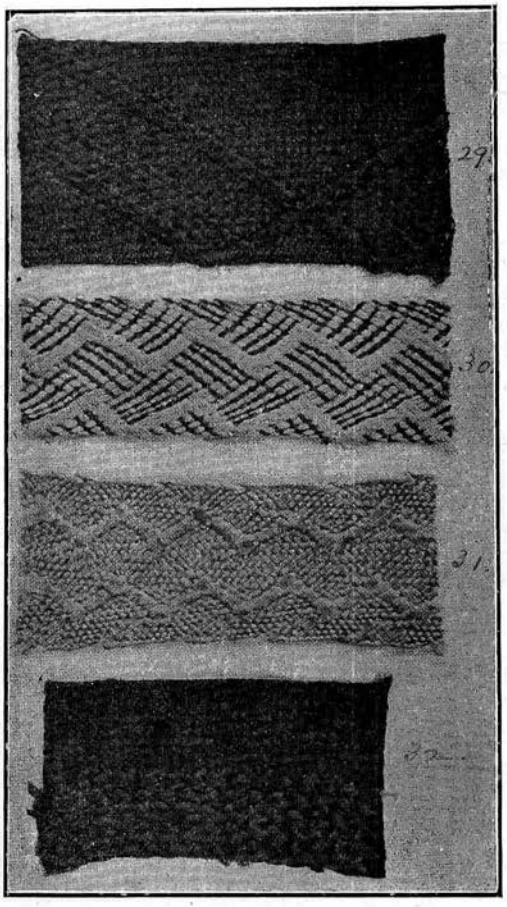
Fig. 25 shows a heavy braid made on a 12-line plain braider with a 3-horn terminal. This braid is made with twelve spools of heavy gimp, twelve spools of narrow braid and twenty-four spools of silk thread interwoven with the heavier materials.

Fig. 26 shows a 4- and 6-line diamond braid. The 6-line braid shows one of the most valuable characteristics of all braided fabrics, namely its adaptability to being laid in curves and circles, so desirable in embroidered effects on ladies' coats and jackets. To facilitate this laying into curves of the braids, a "pull string" is introduced as a warp on one of the terminals. This string consists generally of glazed cotton or some other smooth thread. By pulling on this thread the material forming the body of the braid is crowded laterally and the braid assumes a curved or circular shape.

Fig. 27 shows a peculiar figured effect in black and white, which is produced by distorting the regular diamond figure obtained by mixing two colors in the manner shown in the pattern by means of an irregular take-off.

HERCULES BRAIDERS.

Somewhat different from the type known as flat or plain braider is the Hercules braiding machine. In place of 4-horn gears this machine consists mainly of 6-horn gears and the terminals are 7-horn instead of 5-horn. This means that each thread passes over three under three in the resulting braid structure. This type of machine was originally used mainly for producing braids of considerable strength and wearing quality. Having six threads to the line instead of four, there was considerably more body to the braid and Hercules braids in mohair, worsted, silk and cotton have been a well



Figs. 29, 30, 31, 32

known staple in the notion trade of this country for many years.

Fig. 28 represents a 20-line Hercules machine with 121 carriers. This machine is provided with crown beaters as an ordinary type of beaters would not be sufficient to produce tightly woven braids on so large a machine. The prongs of these beaters, sometimes called umbrella beaters, move radially toward the braid former and assist in overcoming the friction between the braiding threads and warp threads when both kinds of threads are employed.

Of late years another feature of the Hercules braid machine has been developed. This is the possibility of producing changes in the weave by letting some of the carriers run empty. By a suitable arrangement of the terminals, changing them from 7-horn to either 5- or 3-horn, and using full and empty carriers in regular repetitions, braids can be produced that are partly plain and partly diamond weave.

Fig. 29 is an illustration of these effects. This braid is made on a 20-line Hercules machine like the one shown at Fig. 28 by using one 5-horn and one 7-horn terminal instead of two 7-horn. Instead of using the full number of 121 carriers on this machine, part of the carriers are run empty, whereby a change in the weave is produced and shifted from one place on the machine to the next diagonally across the entire machine. Four ends of gimp are employed on four of the braiding carriers to form the demarcation lines separating the diamond from the plain weave.

Figs. 30 and 31 show a peculiar effect obtained by the use of empty carriers on Hercules machines. This design, Fig. 31, is made on a 24-line Hercules machine of 145 carriers. The zigzag ribs running lengthwise are produced by changes of weave due to missing or empty carriers in irregular repetitions.

Fig. 32 shows a 10-line braid, half plain and half diamond, divided in the centre. This pattern is made on a Hercules machine having one 3-horn terminal, one 5-horn terminal and a 4-horn gear in the centre of the machine, in place of a 6-horn gear.

SOUTACHES, PRESIDENT BRAIDS, SQUARE BRAIDS, CORDS AND TUBULARS.

These braids are used principally by the embroidering trade. They are narrow trimmings which can be readily laid into any desired curves and shapes, can be formed into ornaments, loops, etc., and for this reason are principally used where a military effect is desired. This class of braids, especially soutaches and presidents, are generally made with warps. The soutache machine is the simplest braiding machine that can be made, consisting of two plates only, the carriers running in the shape of a figure

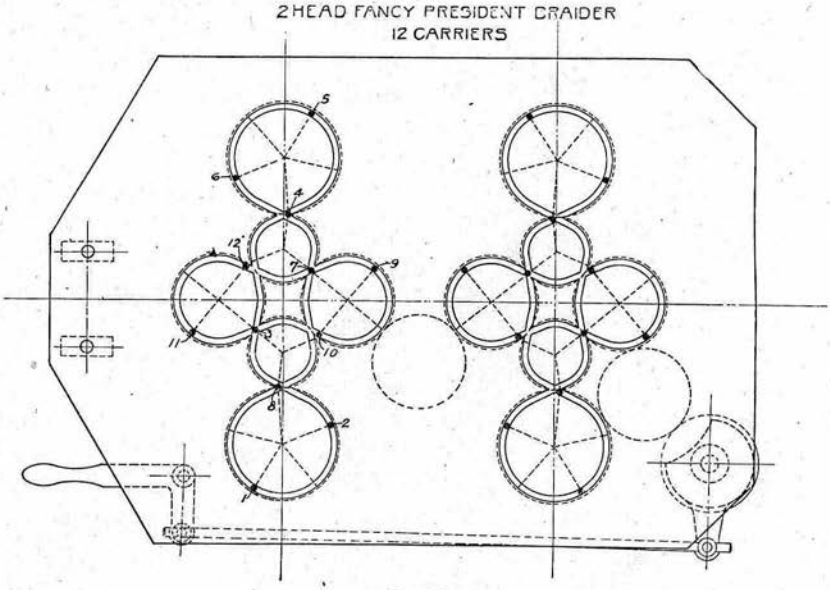


Fig. 33

8. The president braider is generally made with eight carriers, and consists of three plates, generally having a 6-horn gear in the centre and two 5-horn gears on the sides.

Fig. 33 shows a 2-head, fancy president braider. This machine can be used for making plain president braid by employing only the carriers 1 to 8, leaving off carriers 9, 10, 11 and 12, which form the cross run, or running them empty without threads. Ordinarily, however, these machines are employed to make fancy effects, and generally, threads of contrasting colors or materials are put in the centre cross run.

The starting motion shown on this drawing will be illustrated more fully later on, as it forms one of the most recent improvements introduced by the Textile Machine Works.

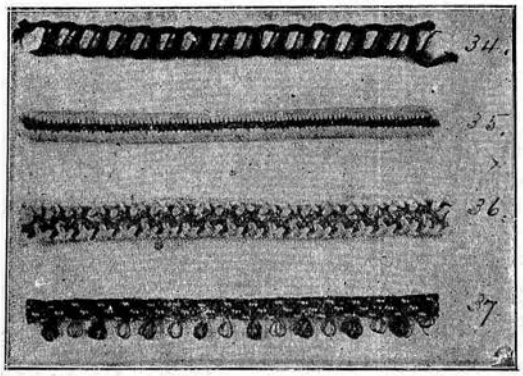
Fig. 34 shows a braid trimming made on a president braider. Either the ordinary 8-carrier machine or the fancy president braider shown at Fig. 33 can be used for it. The centre of the braid consists of a heavy biese; this is a soft cord or strand of cotton wrapped loosely with silk or some other covering material. The colored strands in this braid consist of two ends of gimp and two ends of tinsel. The gimp forms the ladder pattern. The other four carriers of the machine are left empty.

Fig. 35 shows a very popular trimming made on a fancy president braider with twelve carriers. In making this braid eight spools of silk are used which form the main body of the braid, whereas the four additional carriers traversing the main portion of the braid at right angles carry the tinsel threads. Similar braids are often made with a gimp figure in the centre, in which case one of the four carriers traversing the main body of the braid carries a gimp while the others either run empty or carry silk threads of the same color.

Some fancy braids are produced on tubular machines. As a tubular braid is extremely pliable it lends itself readily to embroidery effects.

Fig. 36 shows a tubular braid made from silk biese and tinsel on a 24-carrier round braider. This pattern is made by using only a portion of the carriers and letting the others run empty, every third carrier being run without thread in this instance.

The braid at Fig. 37 is made on a 24-carrier tubular braider with loop attachments. Patterns of this kind are very popular with the embroidery and cloak manufacturers.



Figs. 34, 35, 36, 37

Fig. 38 illustrates a machine for making tubular braids with loops without the use of a loop attachment. It will be noticed that in the braid at Fig. 37 the threads forming the loops must also run through the entire body of the tubular braid. Braids made on the machine shown at Fig. 38, however, can be made with loops of a contrasting color or different material from the color or material used in the main portion of the tubular braid. The loops made on this machine can be made with either one, two, three or four carriers, according to the distance desired between these loops.

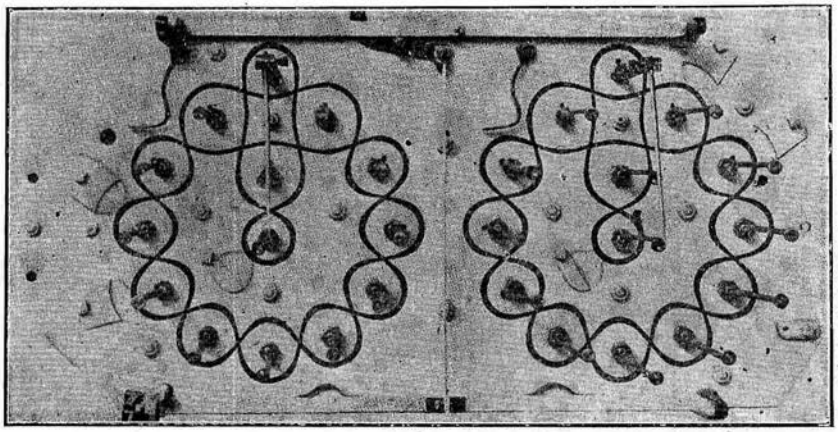


Fig. 38

CORD-EDGE BRAIDERS.

Fig. 39 shows a 19 by 25 carrier, cord-edge braider. This is a very useful machine, and a great variety of patterns for the dress trimming and millinery trade can be produced on it. In comparing this machine with the one shown at Fig. 38, it will be noticed that the auxiliary run traversing the cord portion of the machine is similar in both cases. At Fig. 39 this auxiliary run is continued to form a flat braid, in this case a 5- or 6-line braid, respectively. The 5-line braid is made with twenty-one carriers by using the cut-off change piece now shown in the machine. If it is desired to use twenty-five carriers, the cut-off piece is replaced by two change pieces set into the plate, and the run of the flat braider is continued to the regular terminal shown on the right of the engraving. The product of this machine consists of a flat braid with a tubular braid attached to it.

Fig. 40 shows a regular cord-edge braid with a solid braided cord, such as is used on overcoats, jackets, etc., by seaming the flat braid between two thickness of the cloth and letting the cord form the edge.

Fig. 41 shows a cord-edge braid with a brush edge. This braid is produced by applying a cutting attachment on the machine in such a way that one-half of the carriers passing over the cord portion are laid over a fixed blade of the scissors and formed into a loop which is cut open by the movable blade. Braids of this kind have formerly been extensively used as brush-braid skirt protectors.

Fig. 42 shows a cord-edge braid in two colors, made from artificial silk, with a pe-

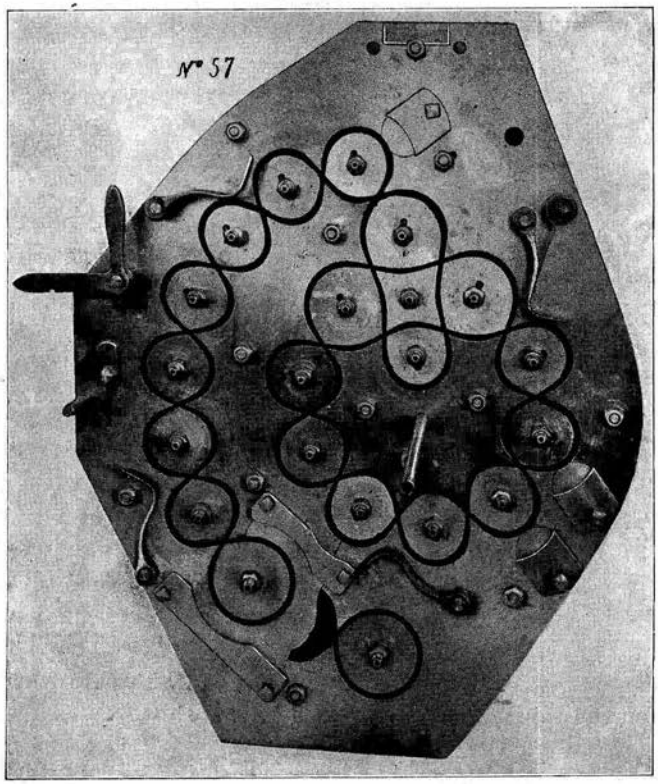
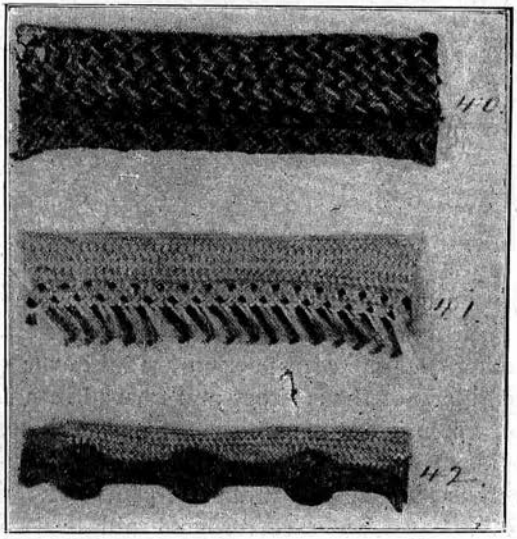


Fig. 39

culiar pattern at the edge, made on the cord portion of the machine. This design is produced by braiding over the material previously cut in this shape in the form of a flat strip, which is introduced as a filling or warp through the centre portion of the machine.



Figs. 40, 41, 42

Fig. 43 shows a cord-edge braid made on a 19 by 25 carrier machine for the millinery trade.

Fig. 44 is also a millinery braid made on a 19 by 25 carrier, cord-edge braider. In this case the cord portion of the braid is made with missing carriers to produce a fancy edge which is often so desirable in the making up of ladies' hats.

AN IMPROVED DRIVE AND STOP MECHANISM FOR BRAIDING MACHINES.

Reference to this new device has been made in connection with a two head, fancy president braider, shown at Fig. 33.

Fig. 45 is a plan view of the new machine. Fig. 46 is an enlarged sectional elevation of the clutch gears and engaging mechanism, showing also the operating connecting rod

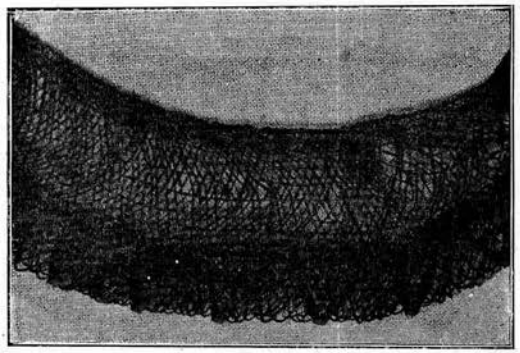


Fig. 43

to the bell-crank and stop mechanism indicated in Fig. 45.

Until quite recently, a wrought iron lever was employed in this type of braiders, which were driven by a common driving bench, and the starting of the machine was accomplished by exerting an upward pressure on that end of the lever extending beyond the front of the machine, and thereby pressing the clutch gear into engagement with the driving gear of the driving bench, the lever being fulcrumed approximately midway of its length. The bell-crank motion of the lever, 35 and 36, and the rotating movement of the arm, 31, permit starting the machine with much greater ease than could be done by the old method, and, in fact, this arrangement makes it possible for the operator to have the free use of both hands if required, as the machine can be started by pushing against the lever, 36, with the knee. Referring to Fig. 46, it will be seen that the intermediate clutch gear, 8, is mounted upon a bolt, 20, extending between the top and bottom plates, 3 and 4; this bolt has its lower end seated in a step bearing, 21, fixed to the bottom plate, while the headed upper end, 22, is secured to the top plate by a screw, 23, so as to permit of it being readily withdrawn for the purpose of removing or changing the parts mounted upon it. The hub of the intermediate gear, 8, extends upward to the top plate, and upon this hub is mounted the clutch gear, 7, which is provided with bottom projections, 24, adapted to enter corresponding recesses in the gear, 8, when gear, 7, is depressed, so as to rotatably engage the two; a spring, 25, however, in the recessed gear, 8, serving to raise the latter clear of such engagement, and thus permit free rotation of the gear, 8. Upon the extended hub, 26, of the latter is mounted a rotatable cam, 27, having upon its upper surface inclined projections, 28, which ride upon corresponding bottom projections, 29, on a fixed cam ring, 30, beneath the top plate, 3, of the machine, so that a turning movement of the rotary cam in one direction will serve to positively depress it, together with the vertically movable gear, 7, to engage the latter with the gear, 8. The rotary cam, 27, is provided with a fixed arm, 31, to which the connecting rod, 32, is suitably jointed for operating the same.

To start the machine the operator merely turns the bell-crank arm, 36, until it is locked to the main stop lever arm, 12, by the catch, 37, the clutch gears being thus forced into engagement by the action of the rotary cam, 27. The stop lever, 10, is connected in the usual way with the stop levers, 11, around the circumference of the machine by means of connecting rods, 14, 32, etc., and a disc, 15.

During the few months that this new de-

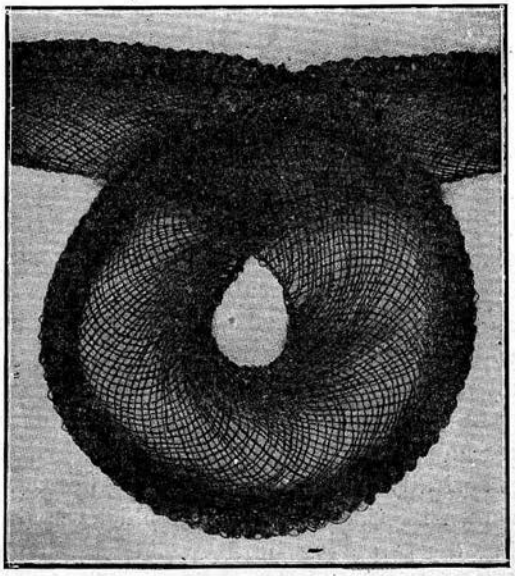


Fig. 44

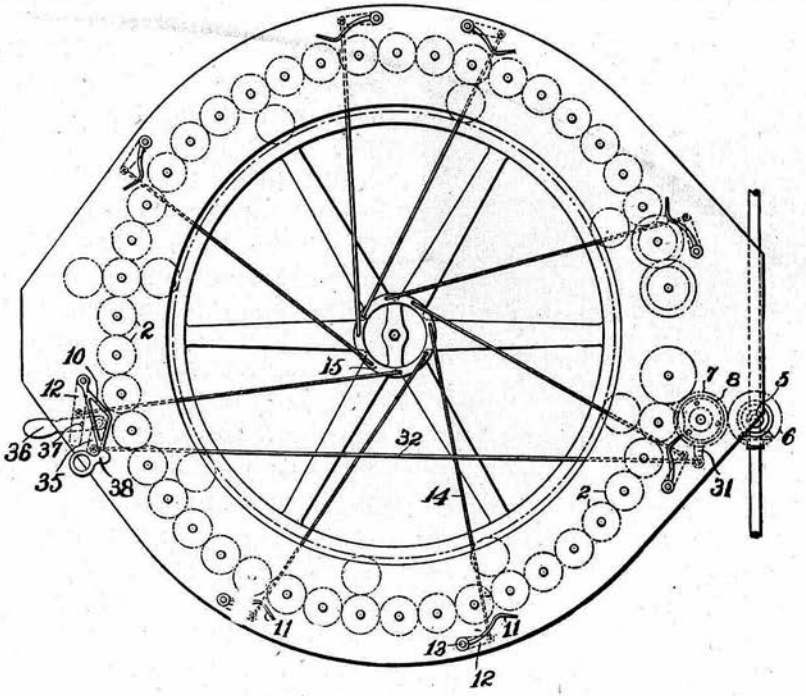


Fig. 45

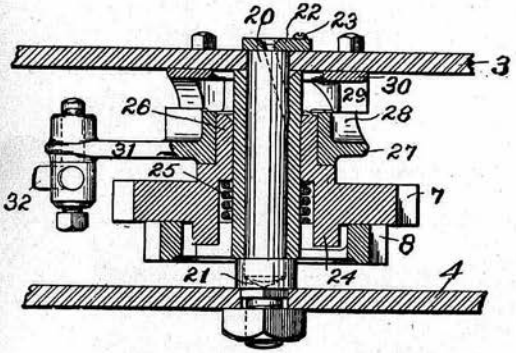
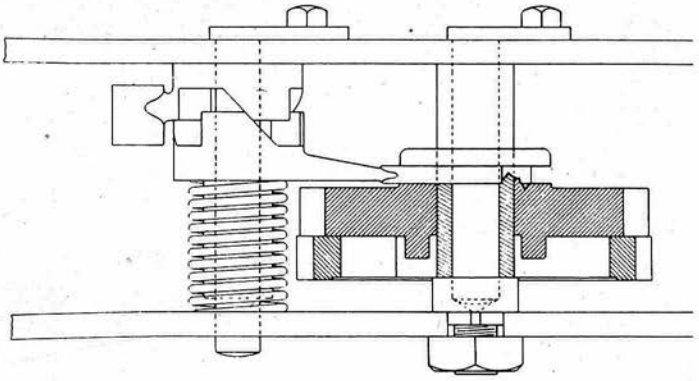


Fig. 46



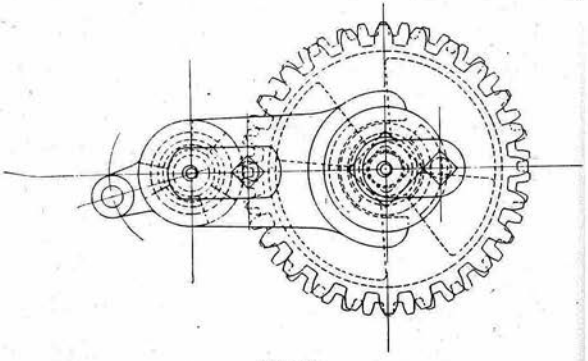


Fig. 46a

vice has been on the market, it has met with a great deal of success, and is recognized as being an important improvement, as it facilitates greatly the starting and stopping of the gear driven type of braiders, which is now almost universally used by the manufacturers of braids.

In Fig. 46a, a modification of the starting mechanism is illustrated. This device is practically a combination of the device shown in Fig. 46 and of the old lever starting and stopping device. The clutch gear is exactly the same as that used with the wrought iron lever, and it was in order to avoid the necessity of introducing a new type of clutch gears that this modification was adopted. Incidentally the advantage of

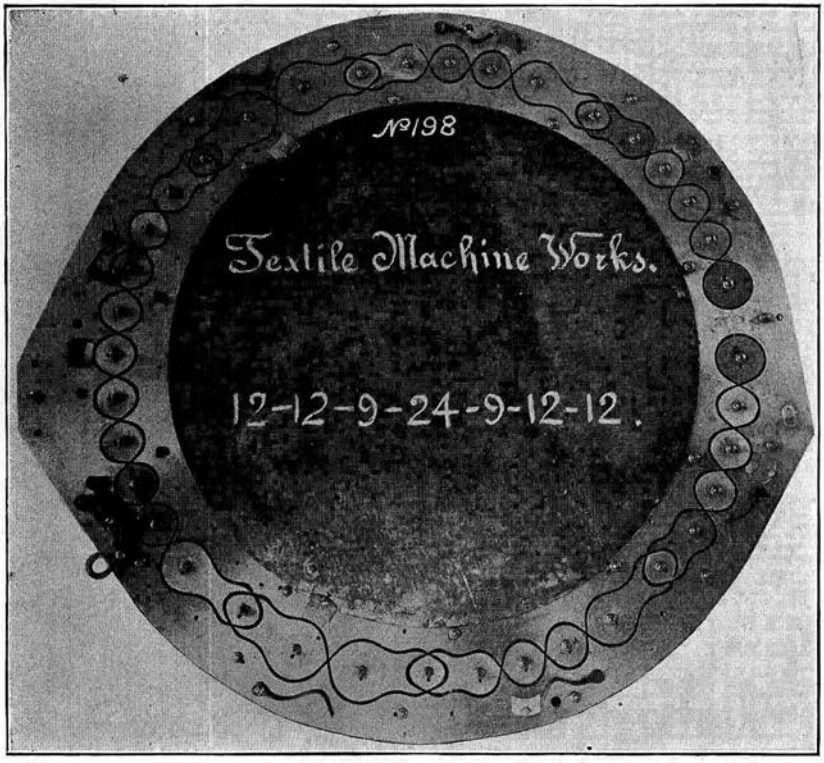


Fig. 47

the modified arrangement is that the spring pressure is exerted under the cam mounted on a separate stud outside of the revolving gears, and the wear incident to the constant pressure of a spring upon a revolving surface is done away with.

STRIPE BRAIDERS.

In all the machines forming the subject of the preceding description, the carriers traverse the entire machine from one terminal to the other. In practically all of them, with the exception of the tubular and fancy president braiders, only one series of carriers is employed. The characteristic feature of the stripe braiders, on the other hand, consists in joining together two or more sections of flat braid by letting all the carriers of two adjoining sections twist around each other on a link plate of such construction that each carrier coming from the right will be returned in the same direction after crossing one or two of the carriers coming from the opposite direction. In order to effect an easy running of these machines supplementary horn gears are used by which the horse shoe type of link plates is developed, as shown at Fig. 47. The bed plate shown here is that of a 7-stripe machine producing a braid with 12 x 12 x 9 x 24 x 9 x 12 x 12 carriers. The centre portion of this braid is practically a 6-line plain or flat braid. To each side of the centre a 9-carrier soutache is formed and on each side of the soutaches a 2-line flat braid, while the two edges of the braid consist of a 12-carrier flat braid of two and one-half lines. It will readily be seen that a great variety of designs can be produced on machines of this kind as each section can carry a different color or material independent of the adjoining section.

Another type of a stripe braider is illustrated at Fig. 48. This is a 24 x 6 x 24 carrier machine and practically consists of two 6-line flat braid sections joined together by

a rotary cros-section in the centre.

Fig. 49 illustrates a very popular millinery braid, made on a stripe braider with 12 x 24 x 12 carriers. The machine on which this braid is made is considerably smaller than the one shown at Fig. 47, but is of the same general construction. The solid woven edge on one side is made from ordinary cotton yarn and is used merely as a support for the rest of the braid when sewed into the shape of a hat. The centre portion is made of narrow strip of straw spread apart by using a very wide former, while the other edge of the braid is a waved braid produced by using irregular tension weights. Contrasting colors could be used on any of the three sections if it were desired.

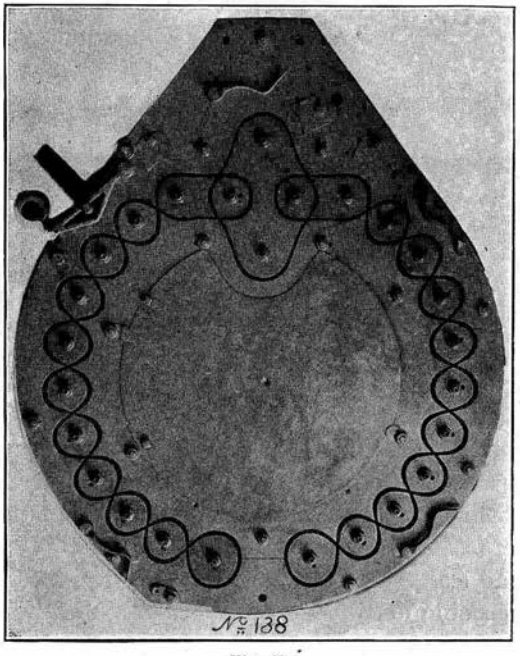
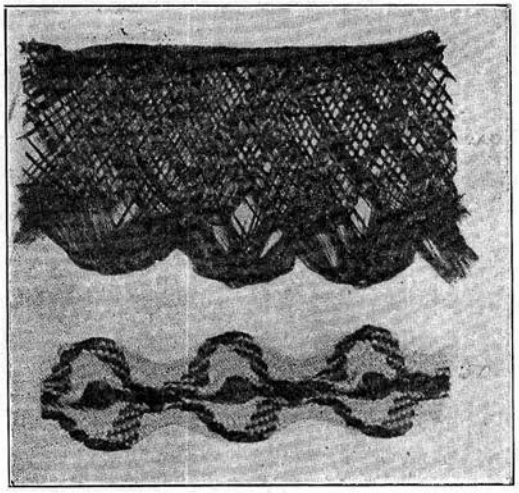


Fig. 48

Fig. 50 shows a product of the machine illustrated at Fig. 48. The varying width of the centre of the braid is produced by uneven tension on the threads of the carriers of the adjoining sections. These tensions are arranged for a waved braid and as each carrier interweaves with one of the other carriers on the middle portion it subjects the latter to the varying tension and changes the width.



Figs. 49, 50

The braid at Fig. 8, described in connection with the intermittent loop attachment, is also made on this machine and forms a good ilustration of its peculiar features.

Still another type of stripe braiders is illustrated at Fig. 51, which shows a 13 x 13 x 13 carrier machine with square cross-overs. In this machine there are link plates arranged to form a cross and it is clear that if materials of contrasting color are used on adjoining sections of the machine a stitch

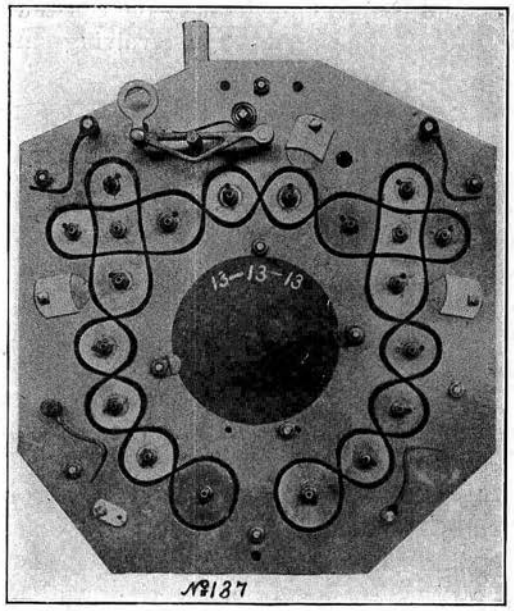


Fig. 51

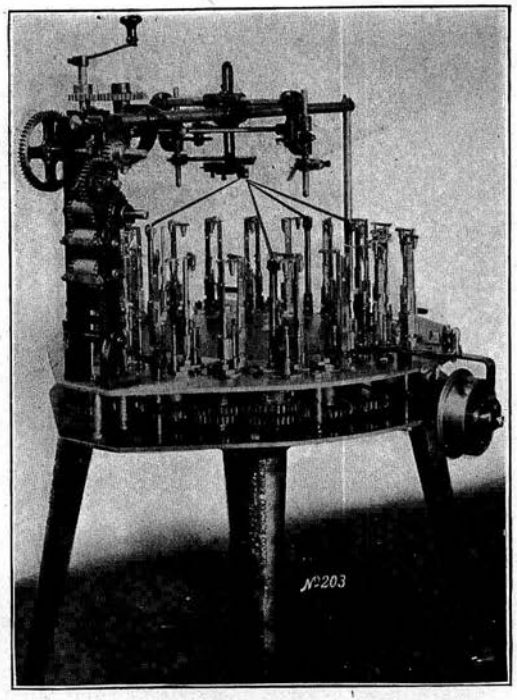


Fig. 52

effect will be produced by the interbraiding of these threads. This effect is often desired as an ornamental feature and is the principal reason for the existence of this type of machine.

Fig. 52 shows a type of stripe braiders patented by the Textile Machine Works. This machine is shown on long legs and belt drive and with outside weight carriers, but the same construction is also used on the regular type machines. The accompanying line cut will more clearly illustrate the principle of this type of stripe braiders. Fig. 53 shows a plan view of the top plate. m and n are automatic switches operated by cams, r, in such a manner that a carrier coming from the left passes over the terminal plate, h, and is returned to the section to which it belongs by finding the switch, n, closed and preventing a passage into the adjoining section. A carrier from the right hand section will find the switch, m, closed, compelling it to return over the terminal, h, to the section to which it belongs. The terminal, h, is in reality a double 3-horn gear. It is provided with six horns, three of which form the terminal for the section to its right and the other three for the section to its left. The speed is equivalent to double the speed which a 6-horn would normally have. The great advantage of this type of stripe braiders over the type with horse shoe plates consists in the closer joints made between two sections. On the horse shoe link plates ordinarily 7- or 9-horn combination gears are used to form a link which results in a rather loose weave, which is objectionable for some kinds of braid, principally for the millinery trade. The type of stripe braider illustrated above is designed to overcome this objection.

The braid at Fig. 54 is made on a 12 x 24 x 12 carrier stripe braider. The narrow edge is made with twelve single ends of glazed cotton. The wide centre is made from one end of artificial horse hair and the straight wide edge portion is made from eight ends of artificial silk spooled together on each bobbin.

Fig. 55 shows a 3-stripe millinery braid made on a 12 x 24 x 12 carrier machine. The centre is made from one end of horse hair, seventeen spools of single ends and three spools of eight ends of artificial silk running in one direction and four spools in another direction forming the diagonal figure in the centre. The scalloped edge is made with

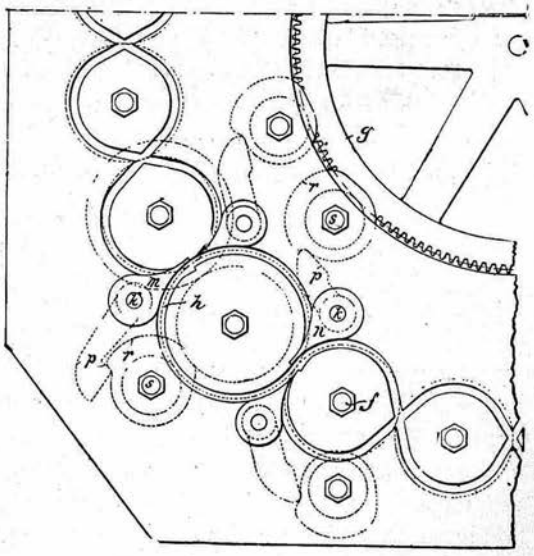
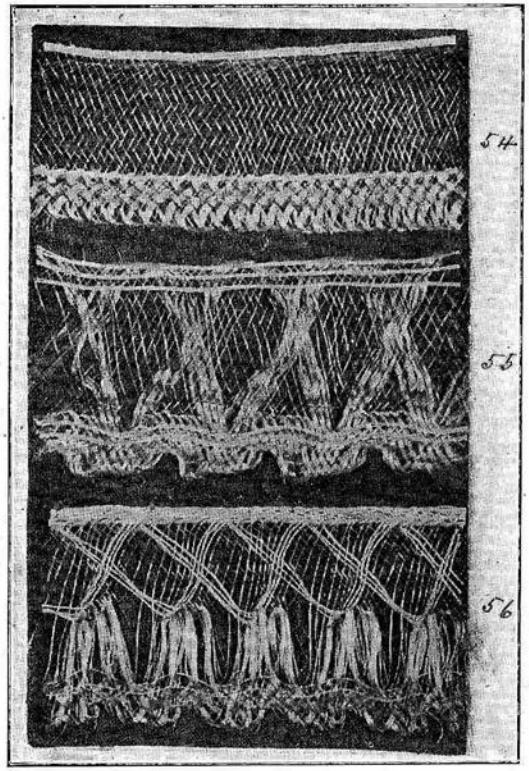


Fig. 53

twelve carriers each of four ends of artificial silk.

The pattern at Fig. 56 is made on a 12 x 12 x 12 carrier machine. The threads between the scalloped edge and the centre portion are loosely drawn over by the heavier tension of some of the carriers on the centre section of the machine. The braid is otherwise similar to Fig. 55.

Fig. 57 shows a 2-stripe millinery braid made on 24 x 12 carrier braider. This braid

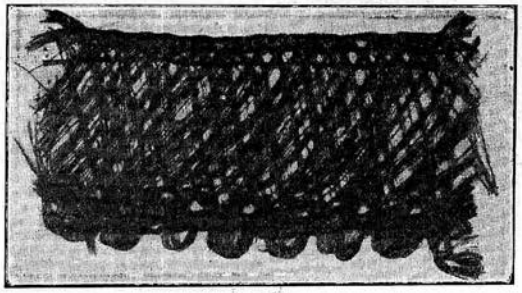


Figs. 54, 55, 56

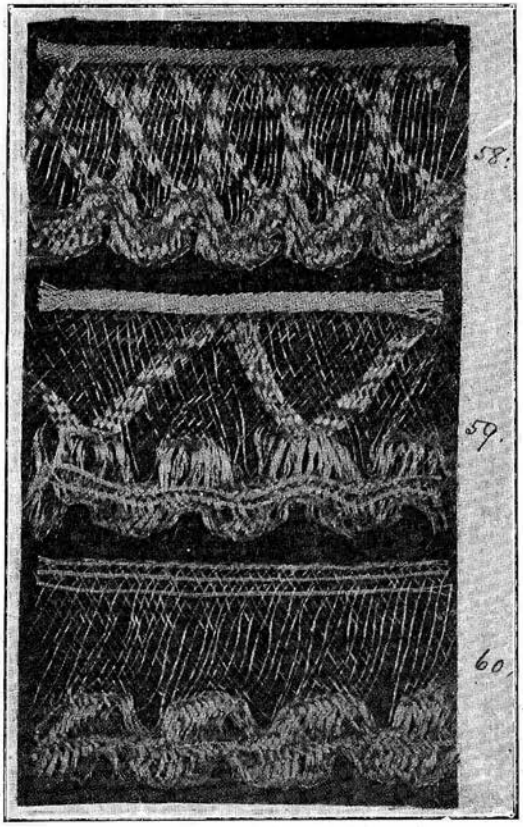
can also be made on a 3-stripe machine, by letting one section of the machine run empty.

The pattern at Fig. 58 is made on a 12 x 24 x 12 carrier braider in the same general manner as No. 55.

Fig. 59 shows a braid made on a 12 x 24 x 12 carrier machine. The tightly woven edge is made of single end glazed cotton yarn. The centre portion is made of twenty spools of one end horse hair and four spools of eight ends artificial silk. The scalloped edge portion is made with uneven tension weights, using two warp threads to form the



Fig, 57



Figs. 58, 59, 60

parallel ribs and assisted by irregular tension on the threads of the centre portion.

Fig. 60 shows a 2-stripe millinery braid made with 22 x 8 carriers from artificial horse hair and wood silk.

Fig. 61 shows a millinery braid consisting of a 21-carrier flat braid made from narrow strip of straw, with additional pattern threads of wide straw braided in. This pattern is made on a new type of jacquard braider.

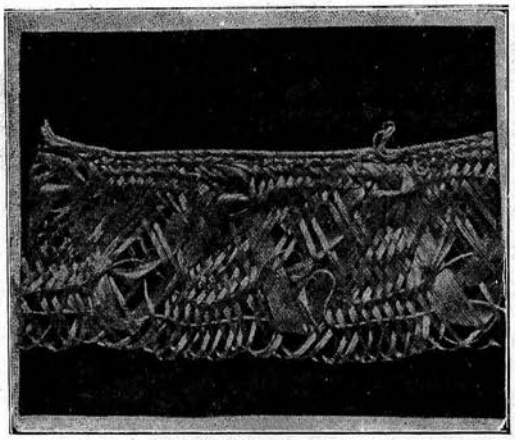


Fig. 61

Figs. 62 and 63 are also made on the same type of machines showing the same general construction. These patterns are among the latest novelties in millinery braids and show really beautiful effects because the edge of the pattern, made from straw, is considerably thicker than the balance of the braid and shows a heavy edge effect, which is so much desired.

JACQUARD BRAIDER FOR FANCY EFFECTS.

Fig. 64 shows the new jacquard millinery braider, on which patterns shown at Figs.

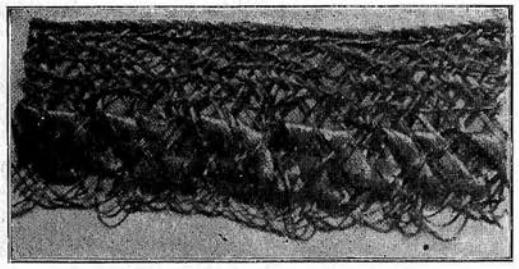


Fig. 62

61, 62 and 63 are produced. The principle of the machine will be better understood by reference to Fig. 65, which illustrates the details of this machine. This machine has a carrier course provided with 8-horn gears in place of the ordinary 4-horn gears, and 10-horn terminals in place of the usual 5-horn terminals. In reality, each of the terminal gears is a double 5-horn, and each of the intermediate gears is a double 4-horn, the course being thus adapted for double the ordinary number of carriers, which may be operated without collision in separate series as desired. The machine is provided with a series of switches. Those on the outer side are operated directly by the carriers themselves and serve merely to round out the carrier groove without, however,controlling

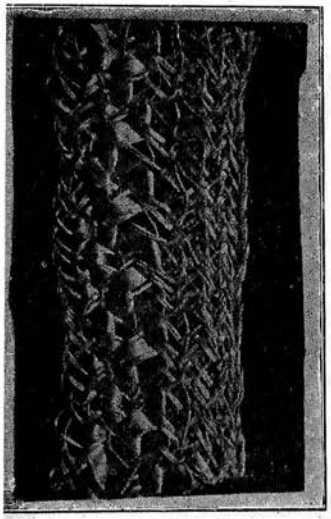


Fig. 63

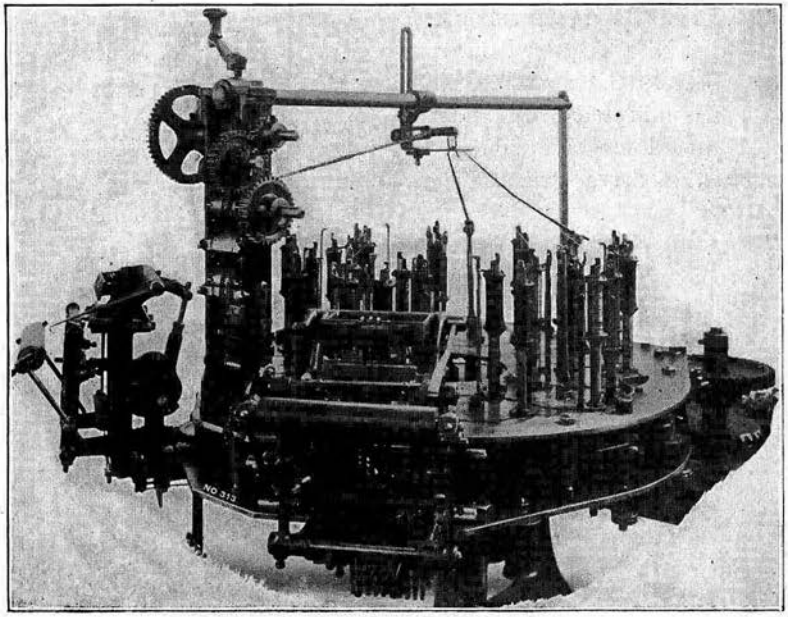


Fig. 64

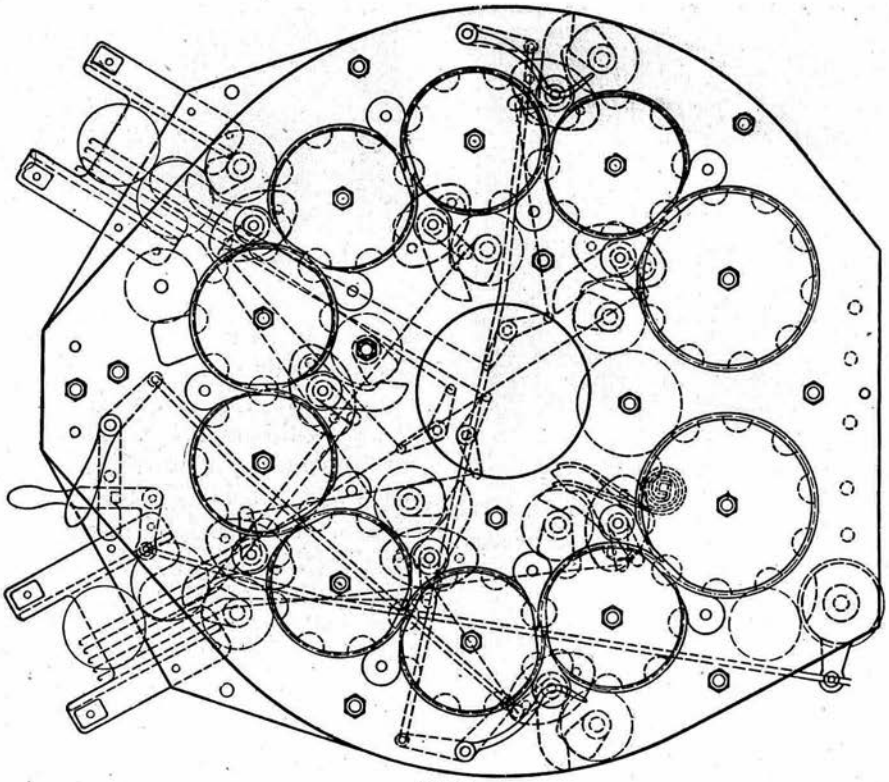


Fig. 65

the course of the carriers. This control is provided by the inner switches, each of which is fixed to a shaft extending between top and bottom plates of the machine. On these shafts rigid arms are fixed by means of which the required movements are transmitted to the switch. This switch mechanism is adapted to be operated jointly by the jacquard mechanism and by cams operated by the drive gears. The combination of these two elements is the main feature of this invention, and is intended to simplify the jacquard mechanism and the operation of the machine by effecting the regular switch movements required directly from the train of drive gears. The jacquard mechanism operates wires connected with each arm of the switch shafts so as to turn each of these as determined by the pattern card employed, while, at the same time, each of these switch shafts is arranged to be turned in the same direction as by the jacquard, but, at different times, by means of the gear driven cams, as indicated in the drawing. This combination of the two switch controlling means makes it possible to produce a great variety of braids on a machine of comparatively simple construction, by using only a few jacquard cards and a relatively slow jacquard mechanism.

It is clear that the machine may also be used for dress trimming braids; however, its chief advantage at the present time appears to be the adaptability for producing novel and beautiful effects in millinery braids.

CROSS BINDING MACHINES.

Fig. 66 illustrates a 2-head, 27-carrier, cross binding machine. This machine comes under the class of lace machines, as the braided product of this machine possesses the main characteristic features of the lace fabric. One head of the machine is shown with the carriers, and the other one, without carriers. The machine is divided into 3 sections of 9 carriers each. Each section forms a 2-line flat braid, and each two adjoining sections can exchange threads by the open-

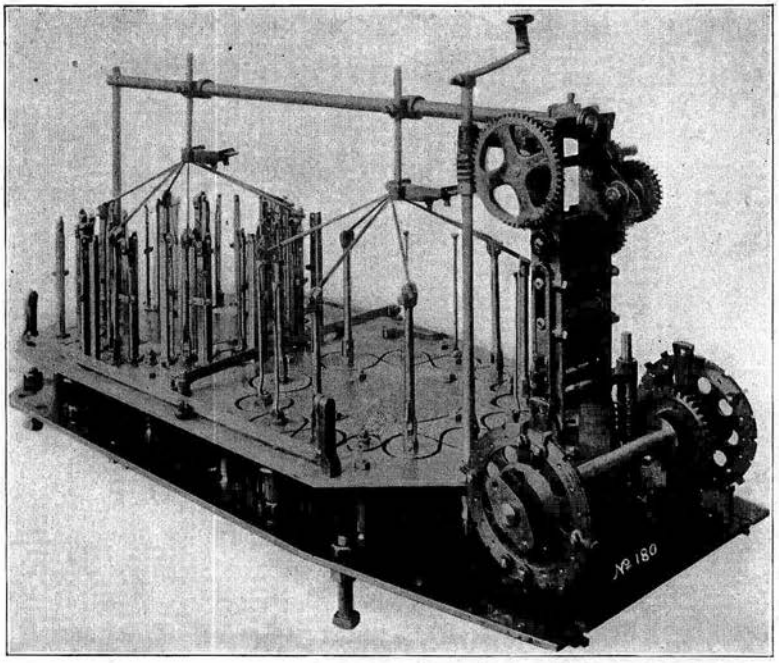


Fig. 66

ing of the switches on the 2-horn gears interposed between each two sections. These 2-horn gears serve only for the purpose of transmitting and crossing the carriers of the adjoining sections, and they run empty whenever the switches are closed. The operation of the switches, and thereby the formation of the pattern, is governed by a jacquard mechanism, in this instance, a pattern disc, shown in the front of the machine. This pattern disc is a somewhat simpler and less expensive means for controlling the operation of the switches in machines of this character, and within the range of patterns that machines of this class are capable of making, these disc jacquards are generally preferred because of the lower price.

Fig. 67 illustrates the product of the 27-carrier, cross binding machine just described. This braid consists of three 2-line (9-carrier) braids joined together by the exchanging of threads from one section to the other. Two of these braids are flat braids made with even tension weights. The one on the upper edge has a pull string warp, which allows of laying the braid into curves. The opposite edge of the braid is formed into a rick-rack in the usual manner of using uneven tension weights.

Fig. 68 is made on an 18-carrier, cross binding machine, but might also be made on a 27-carrier machine by leaving the carriers of one section running empty. In this pattern the centre portion is rounded out like a president braid by the introduction of a heavy warp thread, and a fine loop edge is formed by the use of the loop attachment described in a former article of this series.

Fig. 68, as well as Fig. 67, shows upon close inspection the feature which is characteristic of all products of cross binding machines, and which has given this class of machines its name. The threads connecting two sections of braid cross each other by forming the letter X which is the direct result of exchanging carriers between two sections by means of the 2-horn gear.

Fig. 69 is made on a 12 by 12 by 12 carrier, stripe braider. The open work in the centre is produced by having only three of the centre spindles carry any thread. They are set up with two white gimps and one mixed gimp in between. All the other carriers run empty. While this pattern shows

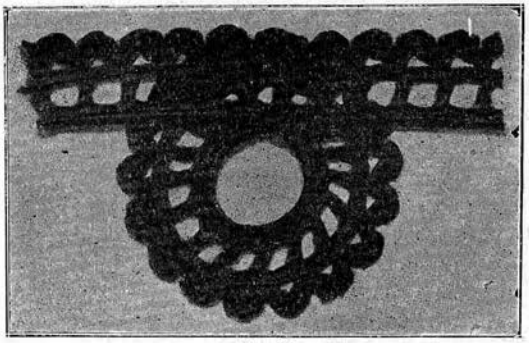
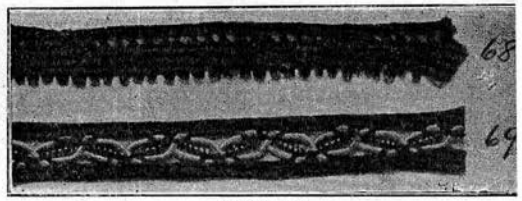


Fig. 67

some of the general characteristics of the patterns described in the preceding illustrations, the essential difference is that the threads of two adjoining sections all interbraid on the link plates, Fig. 69, but do not, and cannot run any further. On the cross binding machine, the adjoining sections exchange carriers, which means that some of the threads of one section must traverse the other section to effect a binding, and vice versa. A braid like Fig. 69 could not, therefore, be produced on a cross binding machine, and it is to point out this difference



Figs. 68, 69

that this pattern is here introduced.

Fig. 70 is another illustration of a cros binding machine of 36 carriers. This ma chine embodies an improvement recently in troduced by the Textile Machine Works which has made the operation of this class of machines more satisfactory than the old construction illustrated in Fig. 66. In Fig 66 the 2-horn gear which forms the connec tion between two sections is interposed be tween two 4-horn gears. The centre section of the machine, therefore, consists of four 4-horn gears which have to take care of nine carriers when the switches are closed Ordinarily, nine carriers could not run on four 4-horn gears without collision, and it was necessary in this type of machines to

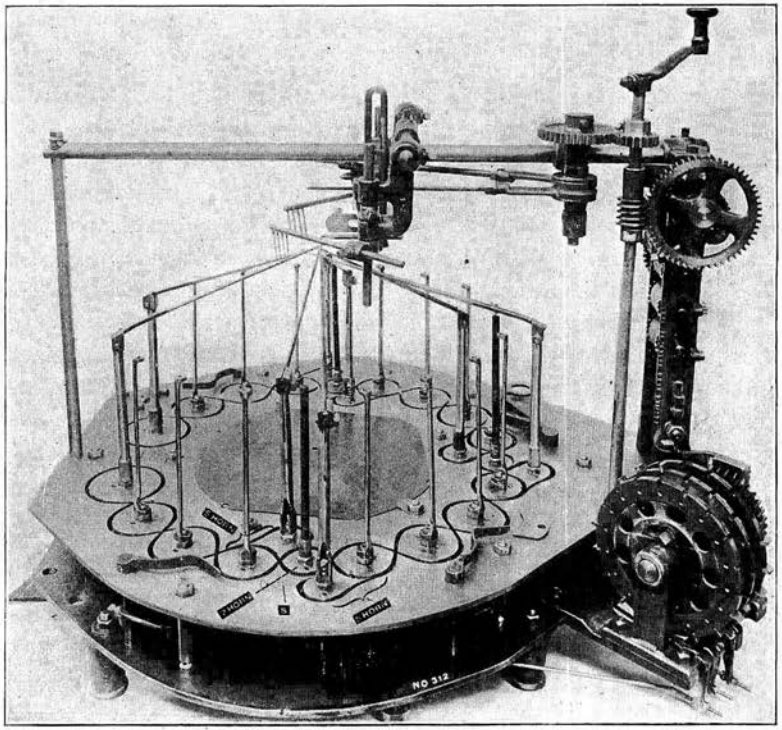


Fig. 70

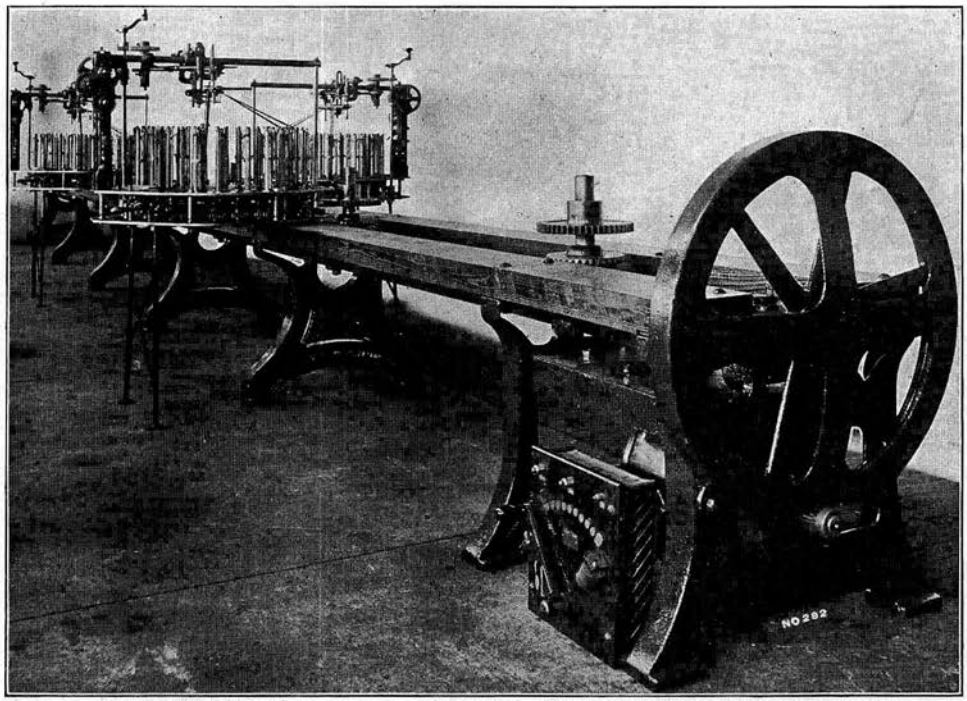


Fig. 71

esort to auxiliary gears retarding the move-nent of the carriers on each of the terminal -horn gears, by bringing them to a sudden top and keeping them at a standstill for the listance of one horn. This was done by neans of an auxiliary gear in mesh with the -horn terminals. One disadvantage of this :onstruction was the hammering and jerking)roduced by the intermittent movement given to the carriers at this point.

The machine illustrated at Fig. 70 over-:omes this difficulty by means of side tracks)roviding combination 5-horn terminals. The two plates or "quoits" shown in brack-ts form a combination 5-horn terminal com-)osed of one 4-horn and one 2-horn gear so onnected by means of suitable transport ears that the combined number of horns is ive. When switch, S, is open, as shown in he illustration, the carriers will all pass ver the 4-horn gears and will cross each ther on the 2-horn gears and connect the wo sections of the braid. In this case the ide track 2-horn is shut off from the adjoin-ng 4-horn gear, and the latter does not serve as a terminal. As soon as the switch, S, is closed, the carriers can no longer pass over the 2-horn gear from one section to the other, but must pass around the side track 2-horn gear, and this, with the adjoining 4-horn, together forms the 5-horn terminal. Each section of the machine forms a complete 2-line braid with nine carriers traveling on eighteen horns.

BRAIDER BENCH ELECTRICALLY DRIVEN.

In the preceding articles a description of all the principal types of plain braiding machines has been given, and before going into the more elaborate machines for producing lace braids and "Radium" patterns, I will describe the latest improvement in the method of driving braiding machines. Fig. 71 shows a braider bench designed by the Textile Machine Works, which has an electric motor built into it and direct-connected to the frame. This motor is fastened under a solid cast iron bed plate in such a manner that it takes away practically no space which

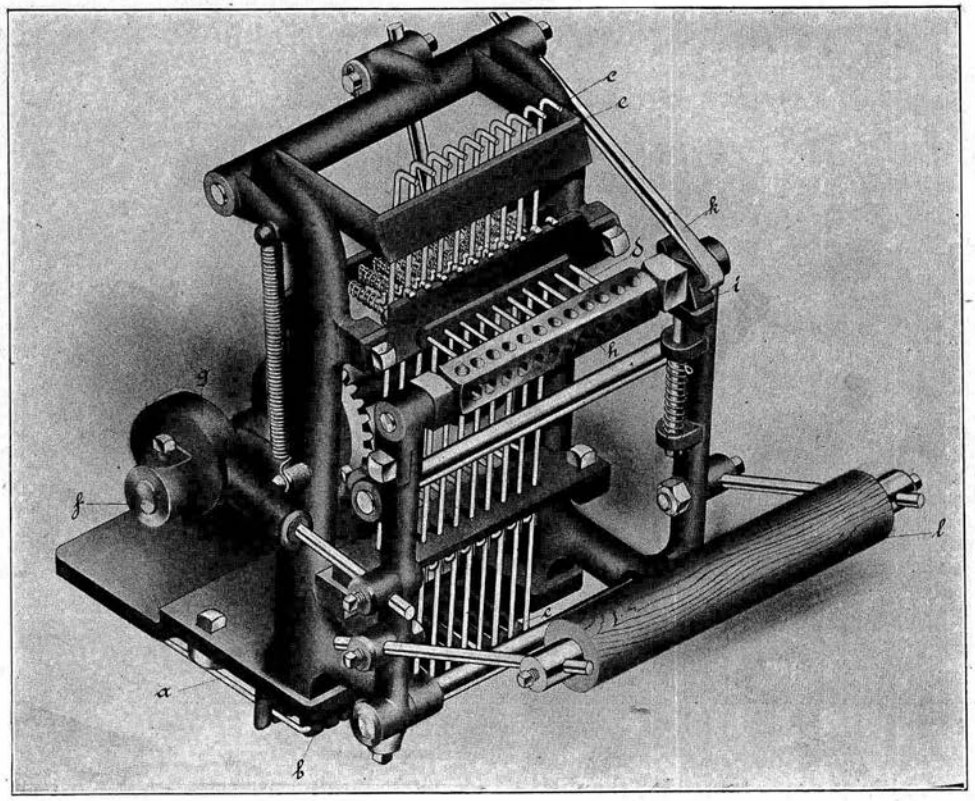


Fig. 72

would be otherwise useful. Usually a 2 h. p. motor is employed, running at a speed of 1,080 revolutions per minute. The shaft of this motor is provided with a pinion which meshes directly into a large driving gear fastened on the main shaft. This large driving gear is 26.6 inches in diameter and has 266 teeth. The motor shaft pinions are furnished with 19, 20, 21 or 22 teeth respectively, which allows of a variation in the speed of the main shaft from 85 to 110 r. p. m.

The driving sets used in connection with these benches have driving gears of 50 teeth. The bevel gears on these driving sets are provided with 36 teeth for the gear on the vertical shaft and 18 teeth for the gear on the main shaft. The speed of the 50-tooth driving gear is, consequently, one-half that of the main shaft. To the left of the motor is shown a starting box, such as is usually employed in connection with electric motors. This device can be fastened at any convenient point on the driving bench and is preferably fastened on a column or against the wall. It is used only in the morning and after dinner when the plant starts work.

The great convenience of the electric drive over the old style belt drive is very obvious. In all the larger cities electric current is available, and it is only necessary to connect the wires to the motor. There are no belts and pulleys to carry dust and dirt, and as a result the rooms remain clean and are more sanitary. The expense of operating braiders electrically is, under ordinary conditions, not more than where the power is transmitted by belts. The friction losses of belt transmission may safely be figured as averaging 30 per cent., and this power is all saved. One 2 h. p. motor will operate a bench forty or forty-five feet long, and will easily take care of 2,000 to 2,400 braider carriers.

The initial expense of the installation is also in favor of the electric drive whenever a new plant is started, as the total cost of power transmission machinery is saved, as well as the expense of an engine or motor to supply the power.

JACQUARD MECHANISM FOR BRAIDING MACHINES.

In some of the preceding articles of this series, I have referred to jacquard machines, which were of simple construction, and in connection with which the jacquard mechanism was used as a modification only of other switch operating means, see Figs. 11 and 64. On the more elaborate types of braiding machines, such as lace braiders and bicircle machines, the jacquard apparatus is essential, and one of the most important parts. Fig. 72 is an isometric drawing of the jacquard motion as designed for braiding machines by the Textile Machine Works.

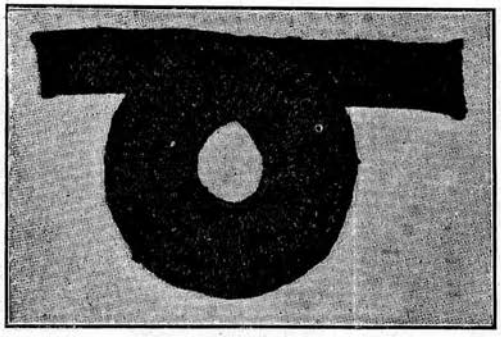
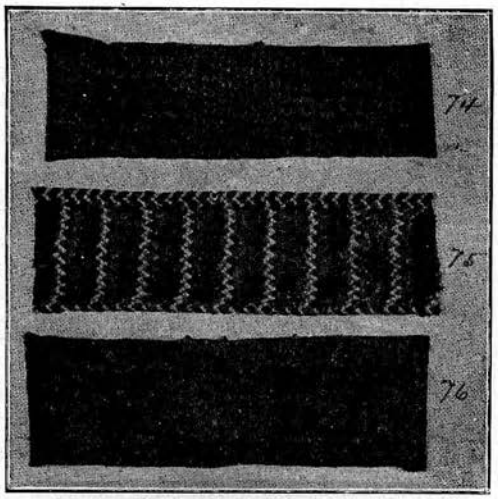


Fig. 73

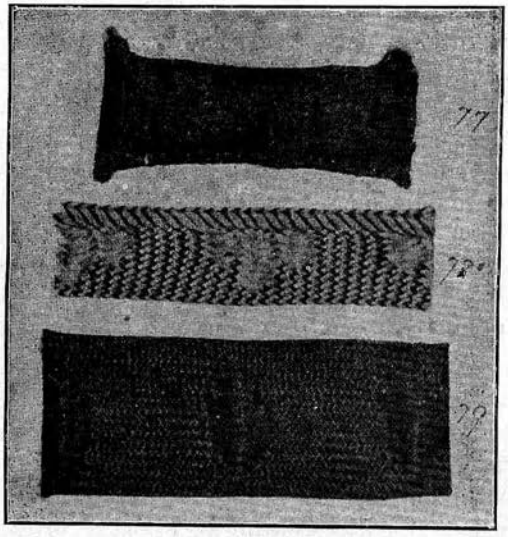
The name, 'Jacquard,' is derived from the inventor of this appliance, Charles M. Jacquard, who first applied an apparatus of this kind to silk looms in the year 1805, in his native city of Lyons, France. This ingenious inventor met with many adversities during his life, but his name will be immortal as long as there is a textile art.

The formation of patterns on braiding machines on which a jacquard apparatus is employed, is effected by the movement of switches which will guide the carriers around the track as required. These

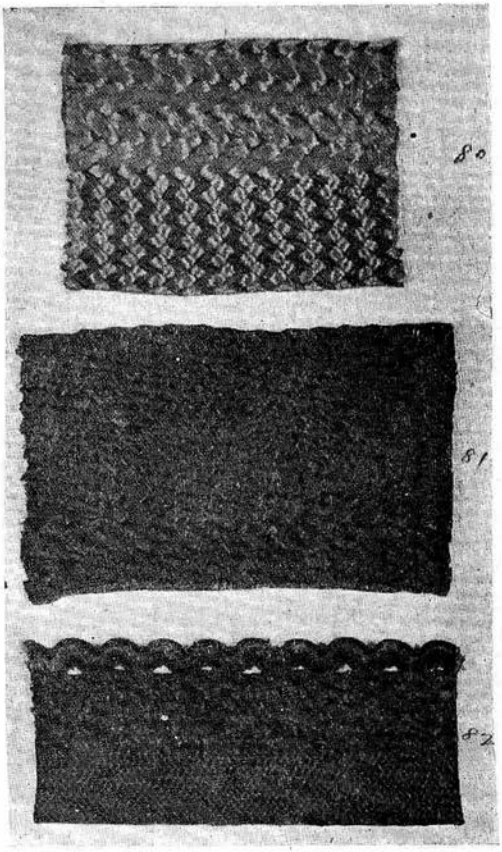


Figs. 74, 75, 76

switches are fastened on shafts extending through the top and bottom plates of the machine. Below the bottom plates rigid arms are fixed on the shafts by means of which the required movements are transmitted to the switch. Wires are fastened to the arms and also to the jacquard apparatus. One of these wires is shown at a, Fig. 72. At b is shown the point where this wire enters a bell crank lever which converts the vertical movement of the lifter hook, c, into a horizontal movement. These lifter hooks, c, co-operate with needles, d, so that by



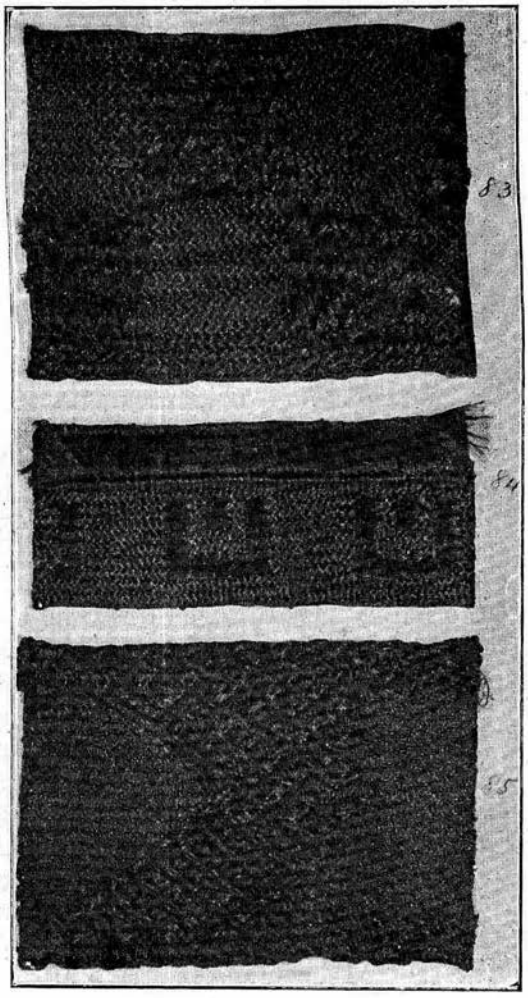
Figs. 77, 78, 79



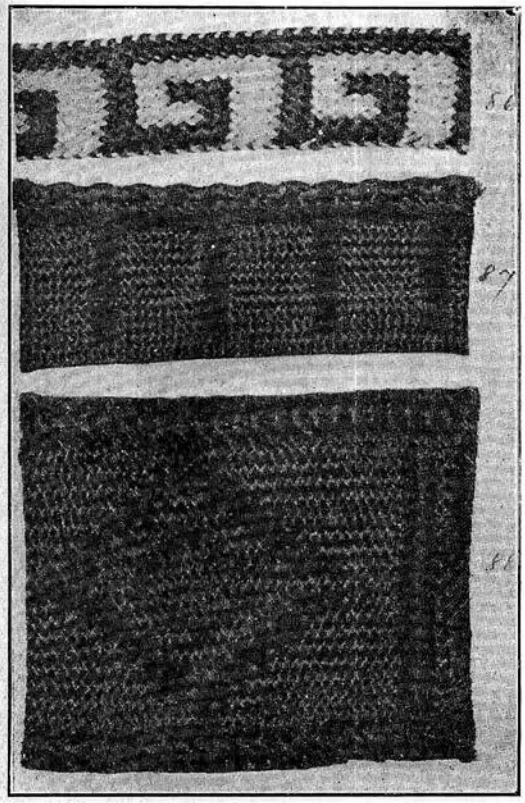
Figs. 80, 81, 82

pressing back the needles, d, the lifter hooks are pushed out of a vertical into a reclined position, and while in this position the lifter or knife, e, clears the hooks and does not exert a lifting movement. The lifter, e, has a constant up and down movement, while the machine is in operation. This movement is derived from an eccentric fastened to a shaft, f. On the same shaft is located another eccentric, g, which provides a reciprocating motion to the frame, carrying the card cylinder or prism, h. The latter is provided with a ratchet, i, upon which a hook, k, slides loosely in such a manner that at every forward movement of the prism, h, and ratchet, i, this ratchet is turned a distance of one tooth. The number of teeth being four, this turns the card prism one-quarter of a revolution. Each revolution of the shaft, f, will bring a new card in front of the needles, d. If a hole is punched in this card, the corresponding needle, d, will enter through this hole and its co-operating lifting hook, c, will remain in the perpendicular position in which it is acted on by the lifter, f, and, therefore, a forward movement is imparted to the wires, a, corresponding with the lifting hook and needle opposite which the hole is punched in the card. As the number of cards can be greatly varied, it is clear that an almost endless number of patterns can be obtained with the jacquard motion. The roller, l, shown in front, can be adjustably arranged to serve as the other bearing for the chain of cards.

These jacquard motions are made with a



Figs. 83, 84, 85



Figs. 86, 87, 88

greater or smaller number of co-operating parts consisting of crank levers, lifters, needles and holes in the prism according to the size of the machine. Sometimes two and even more jacquard devices are put on one braider, depending on the size and type of the machine. The bevel gear shown on the shaft, f, transmits the motion from the braider by means of another mitre gear arranged on a vertical shaft connected with one of the spur gears in the machine.

BI-CIRCLE BRAIDING MACHINES.

While in the chronological order of the development of the industry, the lace braider should be the next subject of these articles, yet this branch of the braid industry is comparatively of so little importance in this country as yet that I will first describe a more recent invention which has proved to be an important development in a comparatively short time.

It had long been the dream of the designers of braided fabrics and of the machine builders to produce figured effects on a braiding machine which would allow unlimited freedom of pattern, similar to the jacquard work produced on looms. In 1900 a patent was taken out by the writer and Henry Janssen, then constituting the firm of Thun & Janssen, for a braid having inter-

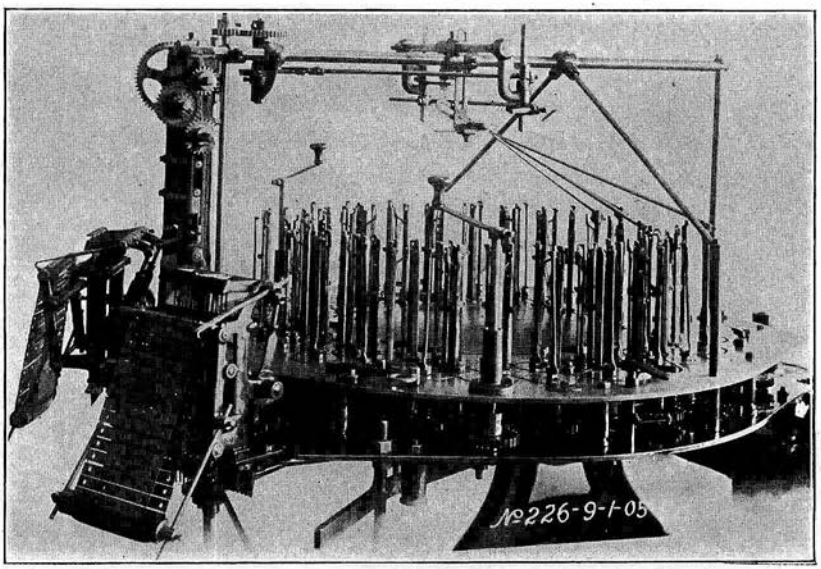


Fig. 89

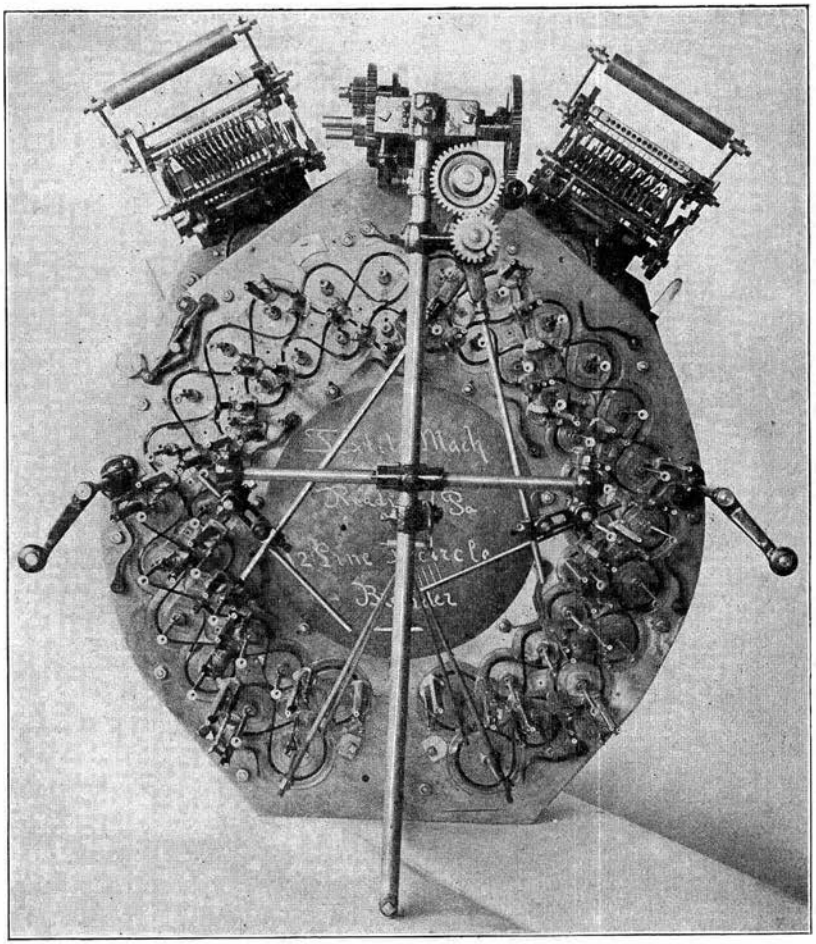


Fig. 90

woven therewith, additional or pattern threads lying alternately on the surface of and between the overlying diagonal threads, as filling threads. These braids were made on a machine provided with radially aligned shuttle tracks intersecting with the serpentine courses of the bobbin carriers. In other words, the machines were braiding machines with weaving attachments. These machines were successfully operated in the shops of the Textile Machine Works, but were never introduced into general practice because it was found that the reciprocating motion of the shuttle carrier was very detrimental to the wearing qualities of the machine, and it was extremely difficult to devise a jacquard mechanism strong enough to control the movements of these weaving carriers. The machine covered by United States patent No. 664,047 shows various constructions of these devices which were afterwards still further improved upon, but all efforts in that direction were abandoned when in 1903 it was discovered that practically the same figured effects could be obtained on a braiding machine having a double track consisting of an outer and inner course so arranged that the carriers could be guided at will from one course to the other by means of a pattern mechanism. The first machine of this kind was a straight machine with sixteen gears arranged in two rows of eight gears each. This necessarily made a very narrow fabric with very limited pattern possibilities. One step further in this direction was to arrange the gears in two concentric circles.

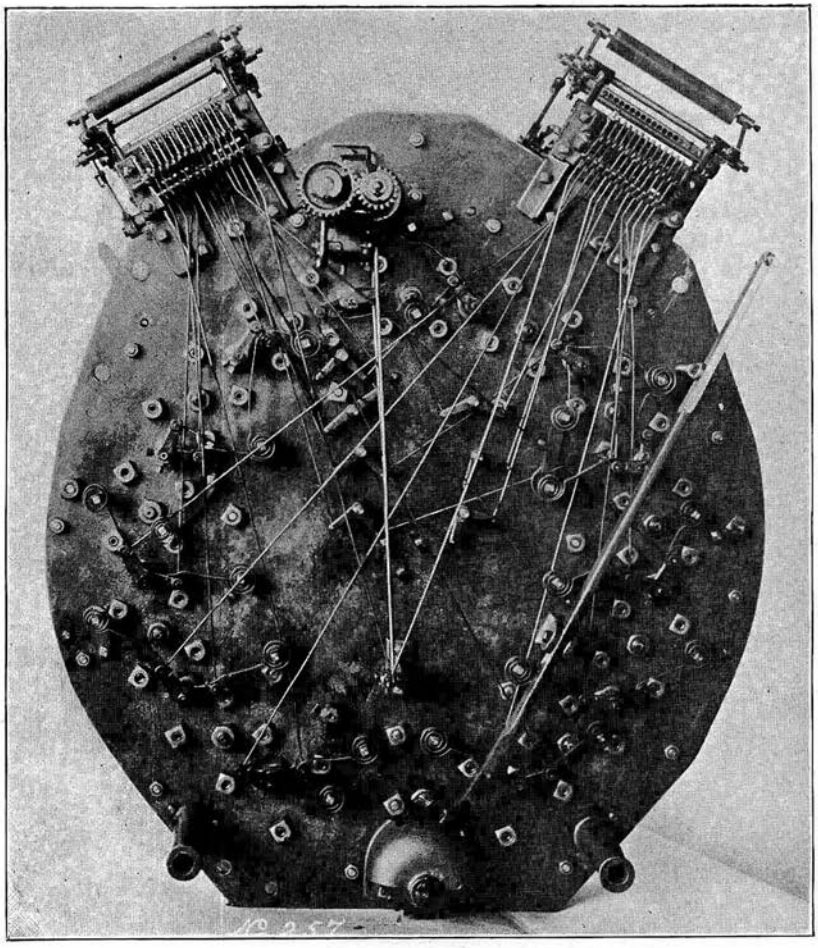


Fig. 91

The first machine of this kind with concentric gear circles was designed in 1903 by R. C. Rahm, chief draftsman of the Textile Machine Works, and an application for a United States patent was filed on October 14, 1904. This patent was granted on June 11, 1907, and bears the No. 856,985. It may safely be stated that with the invention of the bi-circle machine by the Textile Machine Works a new development of the braid industry has been inaugurated, and that the possibilities of this machine are of very wide range.

Before going into a more detailed description of the machine and its mode of operation, I will describe some of its products to illustrate the possibilities of the machine.

Fig. 73 shows a very simple pattern with figured effects resulting from the change of the weave. This pattern is made on an 8-line bi-circle machine, and shows the general characteristic of a braid, consisting in its adaptability of being laid into curves and loops.

Fig. 74 is a similar pattern made on a 12-line bi-circle machine.

Fig. 75 shows a two-colored effect of simple design, made on a 12-line bi-circle machine.

Fig. 76 shows a square block design produced by a change of weave on a 12-line machine.

Fig. 77 shows a Grecian pattern made on a 12-line machine in a single color effect.

Fig. 78 shows a two-color design also made on a 12-line machine.

Fig. 79 shows a leaf figure obtained in solid colors by a mere change of weave on a 16-line machine.

Fig. 80 shows a two-color design with braided soutache effects on one side. It is made on a 12-line bi-circle machine.

Fig. 81 shows a very elaborate trimming made from narrow braids and artificial silk braided on a 12-line bi-circle machine.

Fig. 82 shows a 16-line bi-circle braid with a waved braid edge attached by sewing.

Fig. 83 shows a block pattern made on a 24-line bi-circle machine.

Fig. 84 shows a Grecian design made on a 12-line machine. The wide satin edge is produced by inserting a wide flat filling or warp.

Fig. 85 is made on a 16-line bi-circle ma-

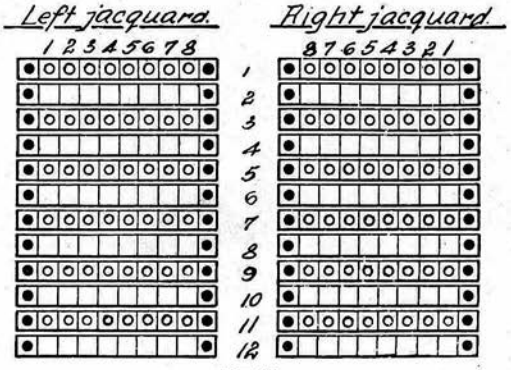


Fig. 92

chine by using narrow braids interbraiding with cords and artificial silk. The design shows a square block alternating with a diamond.

Fig. 86 is made on a 12-line machine and shows a Grecian design in black and white.

Fig. 87 is made on a 16-line machine. In this pattern the waved braid edge is braided right into the pattern by running in a suitable warp.

Fig. 88 is an artificial silk braid made on a 24-line bi-circle machine.

Fig. 89 shows a 12-line bi-circle braider. It will be noticed that these machines are provided with two jacquards, one on each side of the take-up roller stand. The jacquard to the left of the take-up roller stand operates the left hand switches, and the jacquard to the right of the roller stand operates the right hand switches, as will be more fully explained later in analyzing some of the designs. The illustration shows the communicating race circle courses with the carriers, although the photograph does not bring out the interposed switches very clearly. There are forty-nine carriers to a 12-line machine, as on a plain braider. The outer and inner course both consist of 4-horn gears and 5-horn terminals. The outer gears are radially aligned with the inner gears, and the outer course is arranged tangentially to the adjoining circle of the inner course so as to afford communication between the two whereby the carriers of each course may be diverted into the other. To regulate the interchange of carriers double switches are provided between the two courses, the points of these switches being adapted to open or close such communication between the courses as determined by the position to which they are swung upon their telescoping pivotal supports; this position being automatically controlled by the jacquards and wires extending to the switches.

The two race circle courses being arranged concentric, and the gears of both courses on the same radial lines, the outer gears must be of a greater diameter than the inner gears. The horn gears of both courses being arranged for the same number of carriers, it is necessary that they be rotated in equal times notwithstanding the difference in diameters. This necessitates, of course, that the horn gears have to be specially made with every variation of the diameter of the machine, and the horn gears of the various sizes of bi-circle braiders are not interchangeable as is the case with the ordinary type of braiders.

Fig. 90 shows a top view of a 12-line bi-circle braider and brings out the connections between the outer and inner gears and switches controlling the movement of the carriers from one course to the other.

Fig. 91 shows the bottom plate of a 12-

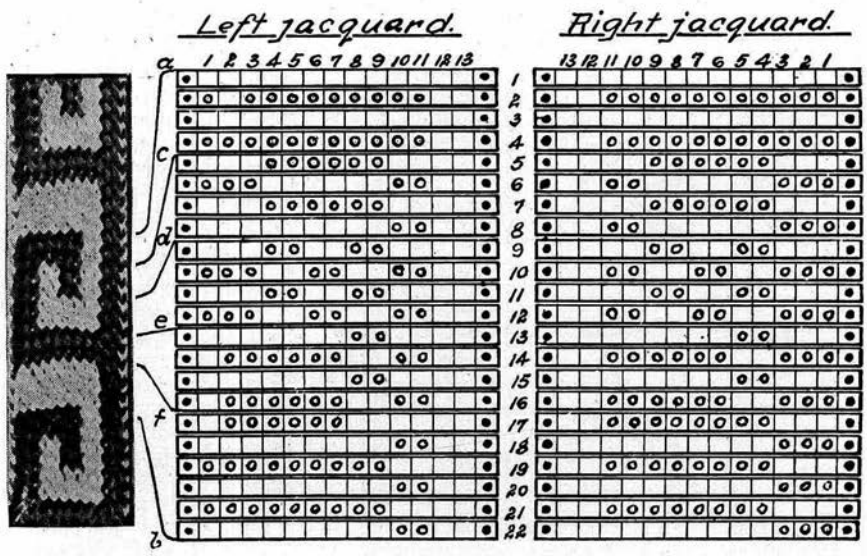


Fig. 93

line bi-circle braider and illustrates the manner in which the switches are connected to the jacquard apparatus by means of wires. Inasmuch as these machines consist of two complete gear circles, it will be clear that two separate braids can be formed by holding each set of carriers to its own course. It is from this feature of the machine that all of the pattern possibilities result. The machine may be used in two distinct ways:—

First, to produce patterns with color effects either by the use of warps or without.

Second, to produce various effects by altering the frequency of the crossings of the threads.

In most patterns a combination of the two principles will be applied, and an endless variation of new effects results from this.

Referring to Fig. 90, it will be observed that switches are provided at every point at which the gears of the inner circle touch the gears of the outer circle. In fact, every one of the points lying approximately on the circle midway between the two concentric gear circles is movable. Wherever in the normal running of the machine the movement of the four gears forming a line is toward the switch points, such switches are what might be termed active switches, controlled by the pattern mechanism of the jacquard. To the right and left of each of these active switches are arranged what might be termed blind or loose switches, as they are not connected to the pattern mechanism of the jacquard. At these last named switch points the movement of the gears, and consequently of the carriers, is away from the points, and the points of the switches are opened and closed by the carriers themselves independent of any pattern controlling means. The only reason for providing movable points instead of fixed points at these places is the fact that the carrier courses can be made closer fitting, and an easier working of the machine results from this construction.

By referring to Fig. 91, it will be noticed that only every second switch has the wire connections to the jacquard mechanism. The active switches are of telescoping construction and consist of steel studs fastened to the bottom plate in the usual manner and forming the support of the diamond shaped piece of the top plate. This diamond shaped piece has two fixed points arranged in a radial line. This steel stud is hollow and has a steel tube inserted through its entire length and projecting below the bottom plate. Attached to the upper end of this

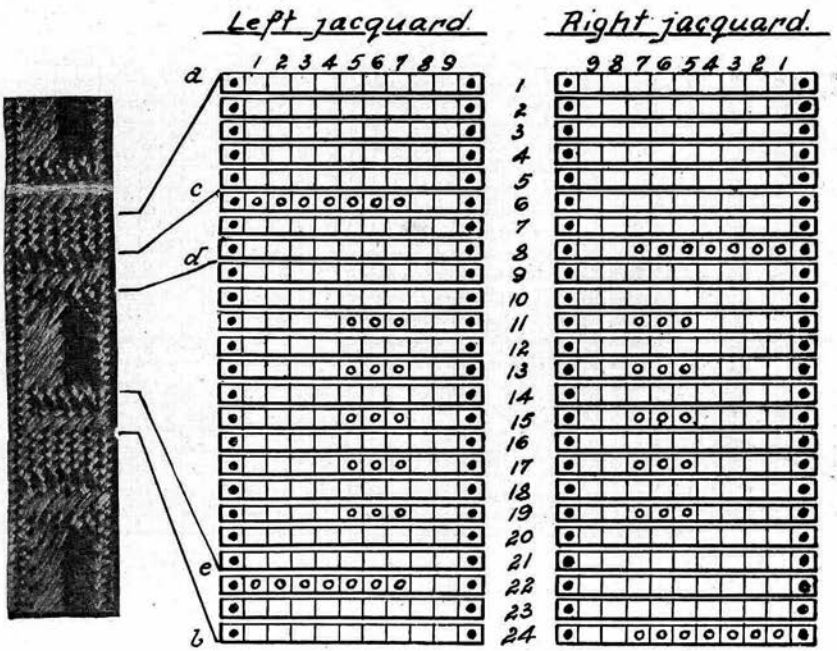


Fig 94.

tube by brazing is one of the movable points. The opposite point is brazed to another steel tube smaller than the first mentioned, which fits snugly into the larger tube, and, being longer than the larger tube, it projects underneath it through the bottom plate. It is due to this construction that an independent movement can be given to each pair of active switches, as is required in the working of the machine.

As the bi-circle machine consists really of two independent tracks for the carriers, each having an independent terminal, it follows that one set of carriers can be run on the inner track exclusively, and form a braid, while another set of carriers can simultaneously run on the other track and form a braid. This can only be done, however, by putting half the number of carriers on each course. The resulting braids would be diamond braids, made with half the number of threads, lying over one under one, and could be made entirely separate if it were so desired. Whenever by means of the jacquard operated switches the two independent tracks for the carriers are so connected that the carriers of the inner course are led over to the outer course, and vice versa, a pattern will result. If differently colored yarns are used on the carriers of the inner and outer courses, figured color effects will be produced. They will show, for instance, as white in black on the outer, and as black in white on the inner side of the resulting braid.

We will now consider the principles which underlie the punching of the pattern cards of the jacquards to produce the above effects. All the carriers may run on the inner track, in which case all the jacquard cards are blank, or they may all run on the outer track, in which case all the jacquard cards are perforated. In both cases the result will be an ordinary plain or diamond braid. A diamond braid can be made by substituting 6-horn terminals for the 5-horn gears ordinarily used. In this case the carriers are set on the machine in pairs, two always following each other. For this class of braids the jacquard is reduced to half speed by means of interchangeable bevel gears. One or all of the carriers may be led from

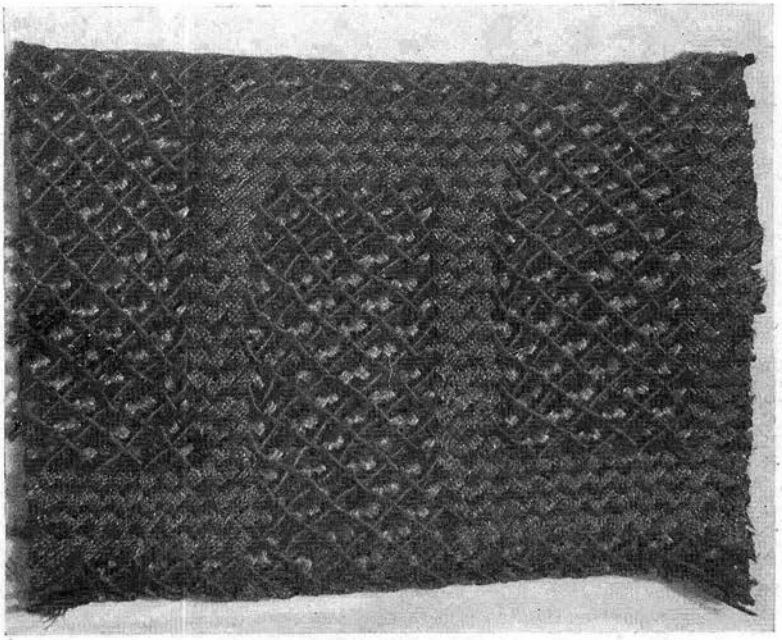


Fig. 95

one track into the other at any point without danger of interference or collision.

These machines are generally so constructed that for the main body of the braid the carriers run on the inner track and are led on to the outer track for producing pattern effects. This practice carries with it the advantage that the bulk of the work is done on the track of the smallest diameter, and that there is, consequently, somewhat less strain on the yarn than there would be on the larger outer track. Some manufac-

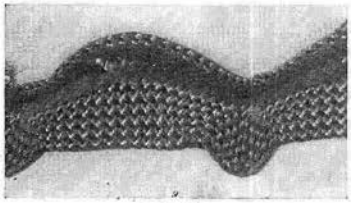


Fig. 96

turers, however, prefer to use the outer track for the main body of the braid and switch the carriers on to the inner track for figured effects. The advantage of this practice is that the loose figures which are sometimes desired, Figs. 76, 78, 79, 83 and 84, appear on the inside of the braid-former and that the braid comes out of the machine with the right side up.

Either practice may be followed on the same machine, except that in one case there will be a hole in the card to make the carrier pass from one course to the other, while in the other case a blank in the card will have the same effect. In other words, for a certain pattern a string of cards may be used that has only a few perforations, and might be called the positive cards for producing this pattern by running the main body of the carriers on the inner track and producing figured effects on the outer track. A negative set of cards would have perforations where the other had blanks, and vice versa, and would produce the main body of the braid on the outer track with the figured effects on the inner track.

This again may be varied by reversing the connection of the jacquards to the switch levers, which can easily be done, as will be apparent by referring to Fig. 91. The pattern drafts, Figs. 92 and 93, are based on having the carriers for the body of the braid remain on the inner track, and the jacquard so adjusted that for unperforated cards the

carriers remain on their course and that a perforation in the card means a corresponding movement of the switch. When all the cards are perforated for all the switches, it is clear that all the carriers must run on the outer track.

Fig. 92 shows strings of twelve cards for an 8-line machine.

Fig. 93 is the same as the one illustrated at Fig. 86, and is repeated here because it affords a good example of a two-color effect. The carriers are set up on the inner course of a 12-line bi-circle machine in the alternate rotation of one black, one white. The pattern indicates that all the carriers throughout the entire braid run over the inner terminals. If we suppose that the face of the braid represents the inner side of the inner gear circle it follows that those carriers whose threads are visible on the face of the braid travel on the inner run, and those carriers whose threads are covered up travel on the outer run.

There are twice as many switches governing the course of the carriers as there are lines in the braid. Half of these switches point to the left, governing the carriers traveling from left to right, and operated by the left jacquard. The other half point to the right, governing the carriers traveling from right to left, and operated by the right jacquard. The first switch which the carrier passes coming from the terminal is No. 1, the second, No. 2, etc. Space 13 on the right and left in this figure are provided for operating a differential speed take-up motion, used in connection with some patterns which will be described later.

We will assume that the jacquard cards of uneven number control the carriers with black yarn, those of even numbers, the carriers with white yarn. As above stated, all of the carriers travel over the inner terminals. Therefore, all the cards are blank at No. 12 on both the right and left jacquard. To produce the pattern twenty-two cards are required, as one unit of the design, or one repetition, as we shall hereafter call it, contains twenty-two picks. The distance from a to b covers one repetition of the design, and it is only for this portion of the braid that we must make the cards.

We will sub-divide this repetition into five parts, a to c, c to d, d to e, e to f, f to b.

Portion a to c, cards 1 to 4. Here we have black on the face and white on the reverse side of the braid over the entire width for two carriers coming from the left and two carriers coming from the right. As the uneven cards control the black carriers, and all of them are to remain on the surface, these uneven cards are blank, and the even cards are perforated, because the white carriers are to remain on the reverse side of the braid.

Portion c to d, cards 5 to 8. Here we have black on each side for three lines and white in the centre for six lines. Reference to the holes in the cards on the diagram will show how the white figure is produced in the centre.

Portion d to e, cards 9 to 12. Here we have starting from the left, three lines black, two lines white, two lines black, two lines white, three lines black.

Portion e to f, cards 13 to 16. Starting again from the left we have seven lines black, two lines white, three lines black.

Portion f to b, cards 17 to 22. Starting from the left we have nine lines white and three lines black.

The above five portions of the braid comprise the entire repetition.

A string of twenty-two cards is thus provided for both the right and left jacquards, and these twenty-two cards are laced together to form an endless belt.

By following the above explanations carefully the reader will have no difficulty in familiarizing himself with the working principles of the bi-circle machines, and the manner in which the cards for a desired pattern are punched. The following directions will always be found useful in designing or laying out the cards for a braid with two color effects. Distribute the contrasting colors on the carriers alternately in regular rotation, then assign the cards with even

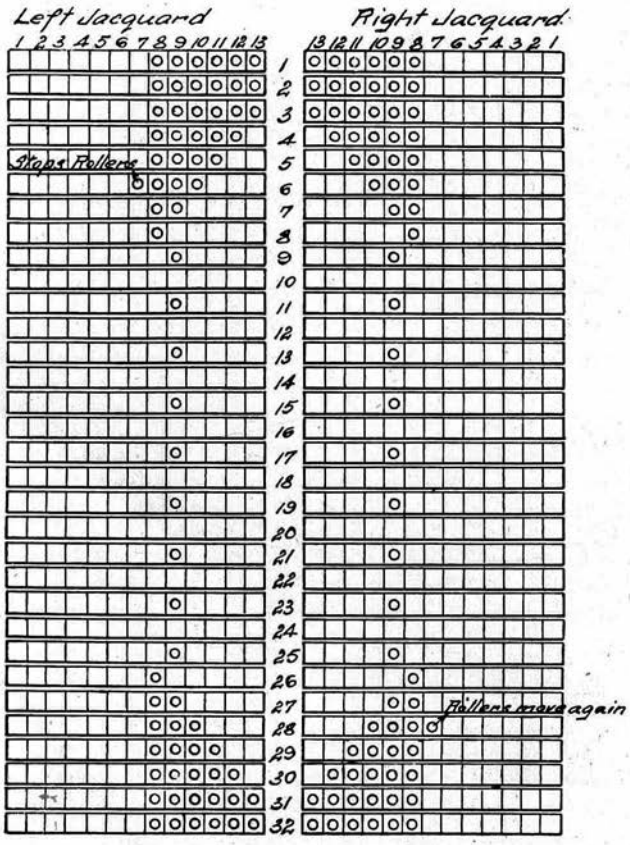


Fig. 97

numbers to one color and the cards with uneven numbers to the other color. Wherever it is desired to have the colors in the braid mixed, the cards should be left blank. At whichever place one of the colors alone is to appear on the surface, the other color showing on the reverse side of the braid, the cards assigned to the color which is to disappear and show on the reverse side of the braid should be provided with a perforation.

These directions will not only be found useful in analyzing braid patterns and laying out the cards to reproduce them, but, in a similar manner new designs can be originated on paper, as the pattern appearing on the braid is practically a projection of the holes punched in the cards.

In the last number we analyzed a pattern of bi-circle braid made with two contrasting colors. Fig. 94 shows a pattern in which the figured effect is produced merely by a change of the weave. Twenty-four cards are required to form this pattern. The pattern is divided into four parts. The first, a to c, is a plain braid; by counting the lines on the pattern, we find that this portion is five lines long, that is, it covers five picks or plaits. This means that the first five cards are blanks, causing the carriers to remain on the inner track.

The second portion, c to d, requires three cards, 6, 7 and 8. This portion of the braid shows a cross soutache, and is formed by first opening the left switches, 1 to 7, on the sixth card of the left jacquard, causing seven carriers to run from the inner to the outer track, by opening afterwards the right switches, 1 to 7, of the right jacquard, as shown by the seven perforations in the eighth card. This causes seven of the right carriers to run over one gear of the outer track.

There are no perforations shown for switches, 8 and 9, on either jacquard. This indicates that on the last two gears on each side of the machine no change from the regular crossing of the carriers occurs, but that a plain braid is formed continuously, as shown by the illustration of the braid at the left at Fig. 94. One line on each side of the

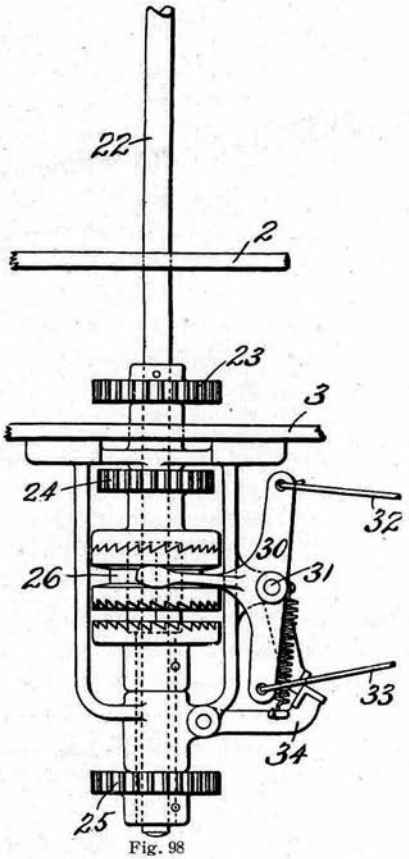


Fig. 98

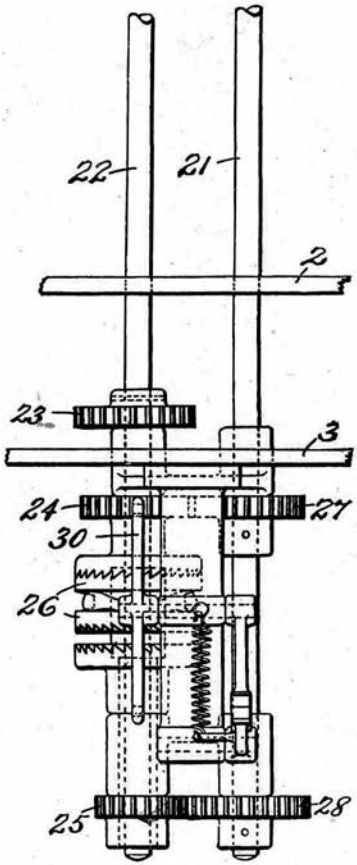


Fig. 99

braid is a regular structure and forms a border for the figured effects produced by the change of weave.

The third portion, d to e, requires thirteen cards, 9 to 21. This part shows a soutache in the centre of the braid running lengthwise. This is formed by running all the left carriers on the left half of the braid and all the right carriers on the right half of the braid over three outer gears successively, as shown on cards 11, 13, 15, 17 and 19. It will be noticed that three carriers controlled by the left jacquard and three carriers controlled by the right jacquard change their course by passing to the outer track simultaneously, and that this is repeated five times. The result of this crossing of the carriers is a wide soutache having its centre rib in line with the centre of the braid. Cards 9 and 10, as well as 20 and 21, are without perforations, indicating that one line of plain braid is formed on either side of the loose soutache effect lengthways of the braid.

The fourth portion, e to b, requires three cards, 22, 23 and 24. This is a repetition of the second portion, c to d; the perforations on the cards are the same as those of 6, 7 and 8.

Fig. 95 shows an elaborate dress trimming, made on a 24-line bi-circle machine, by using 4-line silk braid, silk gimp and artificial silk on the braider carriers. The pattern is a simple one and similar to the one illustrated at Fig. 93 on page 37.

Fig. 96 illustrates a peculiar two-colored effect. The wavy form of the one edge of this braid, and the half circle projections of the opposite edge are produced by uneven tension weights in connection with a differential speed take-up, which will be described later. Fig. 97 shows a very peculiar pattern, known as the medallion effect. This braid consists of a succession of oval portions superimposed one upon the other. It requires 32 cards. The method of changing the weave will be readily understood, as they are very similar to those described in connection with Fig. 94.

Cards 1, 2, 3, 4, 5 and 6 will produce the lower end of the upper section of this braid by causing three times 6, then 5, then 4, then 3, of the left carriers of the right side of the braid and of the right carriers on the left side of the braid to pass to the outer track. On the sixth card a perforation is provided at switch 7 of the left jacquard, which causes the take-up roller to stand and to stop the pulling out of the braid, which remains stationary in the braid former until card 28 actuates switch 7 of the right jacquard and causes the take-up rollers to move and deliver the braid again. The intervening portion of the braid, governed by cards 6 to 28, is made on the inner run, except that every second card causes one carrier from the left and one carrier from the right to pass to the outer track, thus producing a sort of purl effect on the braid. The braid at Fig. 97 requires the machine to be provided with a device to regulate the motion of the take-up rollers in such a way that it can be entirely stopped or operated at two speeds at predetermined intervals regulated by the pattern mechanism. The device genrally employed for this purpose was patented by the writer under date of November 12, 1907, Serial No. 871,004. It is illustrated at Figs. 98 and 99. The usual method of driving the take-off mechanism comprises a series of three rolls with suitable drive gears. These drive gears are in turn driven by a worm gear in mesh with a worm on the vertical shaft which is directly driven from the train of carrier gears. This vertical drive shaft is shown at 21, Fig. 99. The object of this improvement is to provide an intermediate shaft, 22, which, instead of being driven directly by the train of carrier gears at a fixed speed as usual, is driven indirectly at different speeds as desired, so as to vary the speed of the take-off, the object being to vary correspondingly the tension on the fabric. The shaft, 22, is provided with a fixed gear wheel, 23, in mesh with the carrier gears and with loose gears, 24 and 25, of different diameters, either one of which may be caused to rotate with the shaft by proper movement of an intermediate clutch, 26, so as to rotate the take-off drive shaft, 21, at a correspondingly different speed through the smaller gear, 27, or the larger gear, 28, as the case may be. The clutch, 26, is moved, as shown, by a lever, 30, pivoted at 31, and arranged to be swung in opposite directions by tension rods, 32 and 33, with a spring latch, 34, holding it in either position.

The tension rods, 32 and 33, are connected to the jacquards of bi-circle braiders in the usual manner, and one of the spaces of the card prism is reserved to govern the speed. It is obvious that by means of this device it is easily possible to stop the movement of the take-off rollers entirely by removing one of the gears, for instance, 25 or 28. It is also obvious that the relative tightness of the fabric at different portions may be varied at will by a suitable selection of the change gears, 24 and 27, also 25 and 28.

In the last two articles of the present series, a number of patterns of bi-circle braids, "Radium" effects, as they are styled in the trade, have been illustrated and described. A great variation of figured effects has been shown, resulting in almost every case from changes of weave or changes in the rotation of different colors or materials on the braiding carriers, or from both. In nearly every case the braids were made without warps, and, indeed, in the majority of cases, this is preferable, because, by the introduction of warp threads one of the most valuable characteristics of a braided fabric

is lost, inasmuch as the braid is not adapted to be laid into curves. Nevertheless, for straight braids the pattern possibilities on bi-circle machines are greatly augmented by the use of warp threads. To illustrate this, we refer to Figs. 100, 101 and 102, which shows a diagramatic arrangement of the machine and its product.

Fig. 102 represents an eight-line bi-circle machine having 3- and 5-horn terminals, and

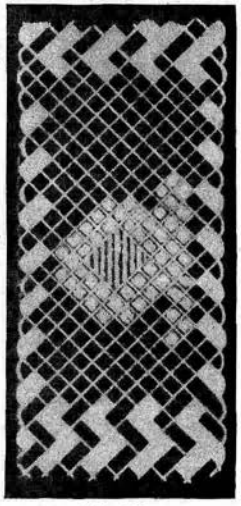


Fig. 100

having all the gears arranged in a straight line to facilitate projection. The gears are numbered from 1 to 16. The lower row of gears represents what on the machine would be the outer gear circle, while the upper row of gears corresponds with the inner gear circle on the machine. On gears 5, 6, 7, 8, 9, 10, 11 and 12, heavy dots in the centre indicate warp threads, whereas, on the switches interposed between these gears and lying between the inner and outer runs, open circles are shown, which also indicate warp threads.

The possibilities of producing patterns by means of warp threads are three-fold:

1. The color or material of these threads as contrasted with the other threads.

2. Their direction parallel to the edge of the braid contrasting with the diagonal lay of the carrier threads.

3. The intermittent floating on the surface of the warp threads at predetermined distances by switching the carrier threads alternately over and under the threads by means of a jacquard mechanism.

Fig. 100 illustrates a braid with figured effects resulting from two contrasting colors carried by the yarn carriers, while the diamond figure in the centre represents the effect of floating warp threads.

Fig. 101 is an enlarged view of the same

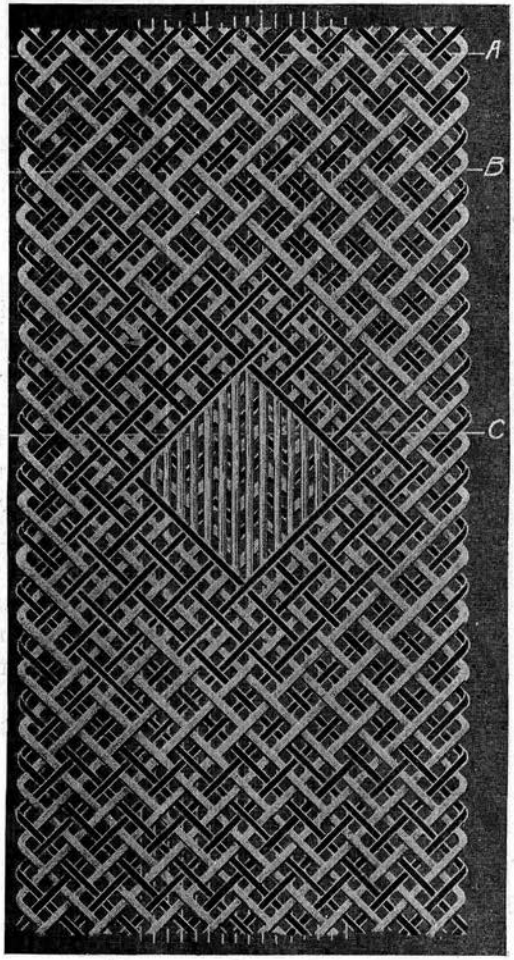


Fig. 101

braid with the individual strands drawn apart to show the structure of this fabric and to conform in projection to the view of the machine at Fig. 102. The straight parallel lines in the centre of Fig. 101 indicate the warp threads.

At Fig. 102 all the carriers are shown on

the outer run and are indicated on the lower gear circle. The braid produced in this manner is a plain braid made with thirty-two carriers, and having enclosed therein, eight warp threads, which pass through the axles of gears 5, 6, 7, 8, 9, 10, 11 and 12. These eight warp threads are, therefore, completely covered by the braiding threads, and show on neither side of the braid. The four warp threads introduced through the axles of the switches will lie loose on the reverse side of the braid in this portion of the fabric. The section, A to B, in Fig. 101, is produced in this manner, and the resulting braid is a striped effect, produced by the regular rotation of the two contrasting colors indicated by the black and white lines.

At B, Fig. 102, the position of the carriers is changed and every second carrier now

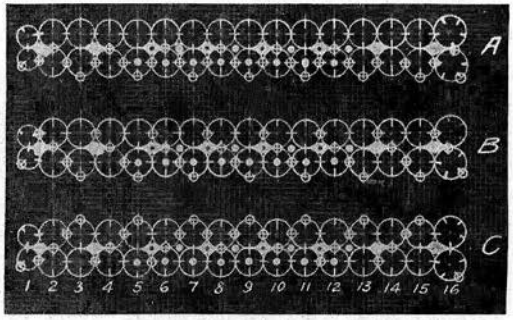


Fig. 102

travels on the inner gear circle so that one-half the number of carriers now belongs to the inner, and one-half to the outer circle, except that on the two terminals all the carriers pass over the outer gear. The braid thus produced is in reality a tubular fabric united at the edges, in which all the warp threads are enclosed so that they show on neither side of the braid.

At C, Fig. 102, the position of the carriers is again changed. At gears 6, 7, 8, 9, 10 and 11, all the carriers are traveling on the inner course, whereby the two series of warp threads are made to lay on the face of the braid to form the desired diamond effect. In this position all the carriers travel over the outer terminals, and on gears 2, 3, 4 and 5, every second carrier travels on the outer course, the rest on the inner course. The cross sectional lines at C, Fig. 101, corresponds with the position indicated at C, Fig. 102.

It is evident that the figure which surrounds the warp threads is produced by similar means, as had been described in analyz-

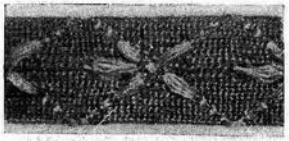


Fig. 103

ing the patterns shown in Fig. 93 in the December, and Fig. 94 on page 38.

The drawing shows the principles governing the introduction of warp threads in producing pattern effects in "Radium" braids.

Fig. 103 shows a very simple pattern with a warp thread effect. The diagonal lines of the contrasting color in this pattern are carrier threads, while the centre lines, parallel with the edges and the dot at the intersection of the diagonal lines are produced by a warp thread.

The pattern shown at Fig. 104 is a fine example of what can be accomplished in figured designs on bi-circle braiders. This pattern is produced on a 16-line, 65-carrier bi-circle machine by having a 3-horn terminal at one side, thus reducing the number of carriers actually used to sixty-four. Of these 32 are black and 32 green, following

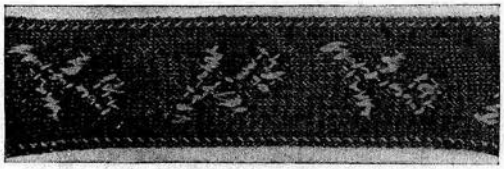


Fig. 104

each other in the rotation, 1 black, 1 green. The narrow line near both edges is produced by a warp thread in red silk, which is so located that all the carriers with black thread pass under it, and all the carriers with green thread pass over it.

The embroidery-like figures in the centre

of the braid result entirely from the use of warp threads. On this braid pattern they are made of red silk, 15 such threads being required to produce the pattern. They lie loosely on the surface of the braid for short intervals as prescribed by the pattern mechanism, and wherever they do not appear on the surface they are covered up and enclosed by the carrier threads passing over and under them.

TORCHON LACE MACHINES.

In all the preceding articles I have described different machines for making plain and fancy braids for the dress and millinery trade. With few exceptions, all of the patterns that have been illustrated were solidly braided, while in some instances, open work effects were shown. Most characteristic among these were the patterns illustrated in connection with the cross-binding machines, and, indeed, the construction of this machine already shows the underlying principle of the lace braider.

A lace as an ornament or trimming consists of designs formed by the crossing and twisting of threads in such a way that the figure of the lace becomes prominent by the contrasting background which it is calculated to enliven. The making of laces by hand is very old and probably dates back to the fifteenth century when the art was known in Italy, Spain, Germany and the Netherlands. The process of making hand-made laces consists in twisting and crossing threads on needle cushions in such a way that the yarn-carrying bobbins are manipulated according to the needles stuck into the cushion to mark the pattern. This process of lace making is probably the oldest of all hand processes and is today extensively carried on in some countries. Linen thread is usually employed on account of the great strength of this fibre and its quality to resist the action of the elements. Cotton, woolen and silk thread are also employed, and, in some cases, tinsel and other fancy materials. As the making of laces by hand is an exceedingly slow and tedious process, and requires great skill, this product has always been very high priced, in spite of the fact that the makers of the lace work get very small wages.

The hand process of making these torchon laces conforms very closely to the braiding operation, and it is, therefore, not surprising that in the great development of the braiding machines the problem of producing these laces by machinery should have received attention. The first machines of this kind were built about thirty years ago in Barmen, Germany, and this city has ever

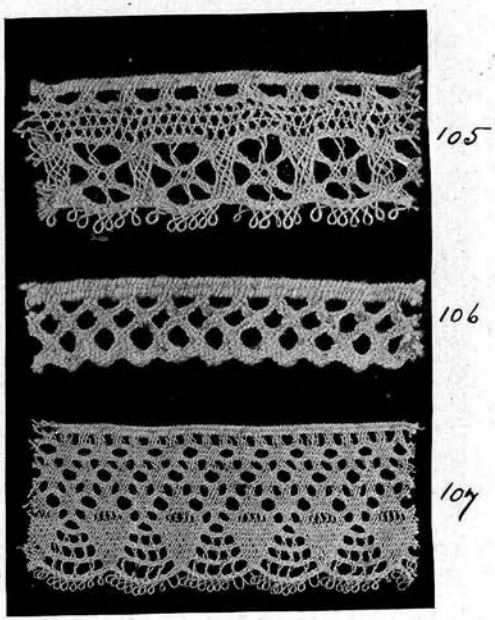
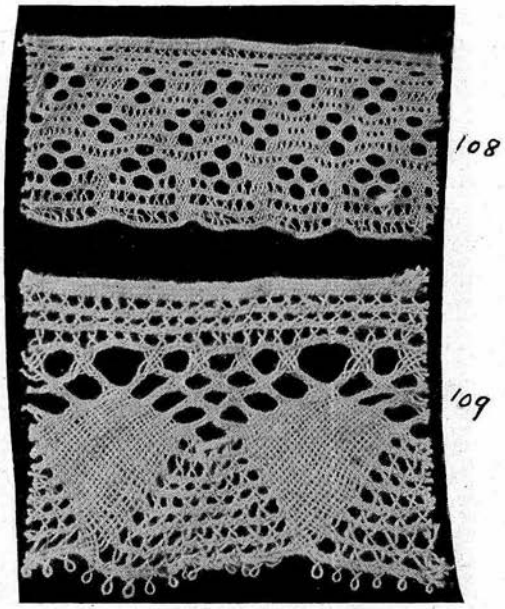


Fig. 105

since remained the centre for the manufacture of machine-made torchon laces. By no other process can so close an imitation of a hand-made lace be produced than is possible on these highly specialized braiding machines. The so-called Nottingham laces or the Plauen laces show their machine-made origin much more closely.

The only disadvantage which the braiding process for making laces has over the weaving process employed on other machines is that only one narrow strip of lace is made at a time, and the quantity of the product produced per day is small compared to the cost

of the machine. On the other hand, changes in design can be made very rapidly by putting another set of cards on the jacquard apparatus of the machine, and, while the machines themselves are highly developed and more or less complicated, the running of the machines is comparatively simple, and inexperienced operators can be employed. A replenishing of the bobbins is practically all that is required of the ordinary machine hands, and all the adjusting and setting of the machines can be left to a foreman. One good foreman can look after a hundred or more of these machines, and one operator can ordinarily take care of about twenty.



Figs. 108, 109

The machines for producing these torchon laces are divided into three classes, according to the number of carriers per line or section of the machine.

Class A. Four-thread lace machines, consisting of a plurality of sectional courses connected by switch controlled pass-over tracks, each sectional course being supplied with four carriers. The product of this machine is called a four-thread lace, and, according to the width of the machine, the lace has as many lines or bars as there are sectional courses.

Class B. Three-thread lace machines, consisting of a plurality of sections with three carriers to each section and provision for passing the carriers from one section to another by means of jacquard controlled switches. The product of these machines is a lace, the individual bars or strands of which are composed of three threads each.

Class C. Two-thread lace machines, producing a lace with only two threads to each bar or strand. The sections of these machines generally consist of three gears operating two carriers, with switch-controlled connections between each two sections. On some types of these machines only two gears to each section are employed.

In order to illustrate the characteristics of the various types of torchon laces, according to the three classes, we call attention to the illustrations.

Fig. 105 is a torchon lace made on an 8-line, 4-thread lace machine, out of ordinary 2-ply cotton yarn. The loop edge on one side is produced by running the carriers over a side track terminal, which is provided with a selvage needle having a wire end extending into the braid former, around which the threads pass and form a loop. The tight twist of the individual thread causes these loops to close and form a figure 8 design. This pattern is a cheap lace, loosely woven and consequently giving a large production.

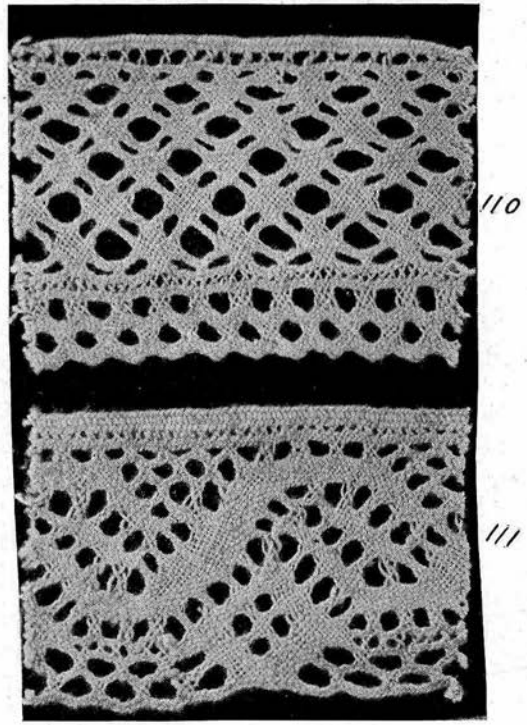
Fig. 106 shows a 5-line, 4-thread lace pattern of coarse design. In this pattern the straight top bar is made with four braiding carriers only and two heavy warps, resulting in the formation of a soutache. The wide bar at the bottom consists of two lines, eight carriers being employed in forming this. In producing this pattern the switch connections between the fourth and fifth lines always remain open. This pattern is made from 16-2, and the product of a machine is about 72 yards in ten hours.

Fig. 107 shows a 12-line, 4-thread lace of a somewhat more complicated pattern, and made of a finer material. The soutache effect at the top bar is also made by the use

of warp threads, and the loop edge on the opposite side is produced by means of side-track terminals. The yarn is 2-40 cotton, and the product of a machine is approximately 50 yards in ten hours.

Fig. 108 shows a 14-line, 4-thread lace of a similar pattern as the preceding one, and made from the same yarn, and with approximately the same production.

Fig. 109 is made on a 16-line, 4-thread lace machine, and is a typical 4-thread lace pattern. The large diamond shaped, solidly



Figs. 110, 111

braided portion forming the characteristic figure of this lace indicates that machines of this kind produce a regular flat braid of diamond or basket weave when all the switches are open. This pattern is made from 2-24 cotton, and a machine will produce about 8 yards per hour.

Fig. 110 shows a pattern made on an 18 line, 4-thread lace machine. On this pattern the lower two bars represent two lines each, each being made with eight strands. The yarn used is 2-20 cotton, and the production about eight yards per hour.

Fig. 111 shows a 16-line, 4-thread lace made of 2-20 cotton. The production of this pattern is about 8 yards per hour.

Fig. 112 shows a black silk lace made on a 6-line, 4-thread lace machine. The ma-

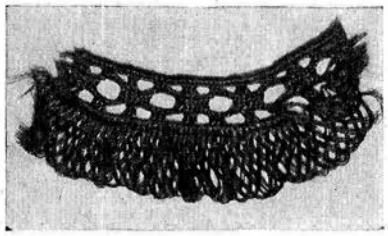
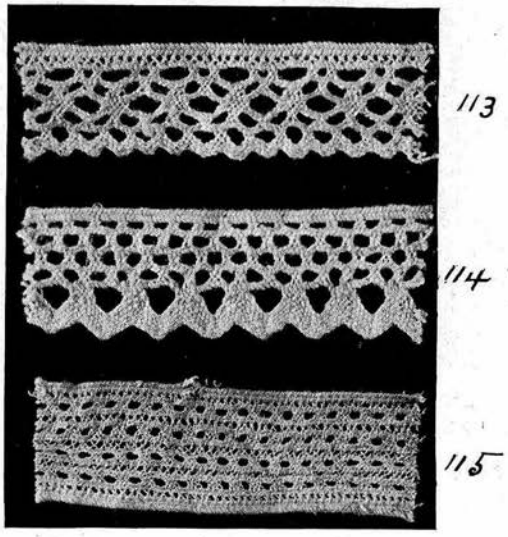


Fig. 112

terial is artificial silk. The lower half of the pattern shows the characteristic features of the 4-thread lace, while the upper half shows a lace edge produced by causing the threads to braid over needles or wires extending into the braid former and spreading the fabric.

Fig. 113 shows an 8-line, 3-thread lace made from 2-20 cotton. The production is about 6 yards per hour.

Fig. 114 is made on a 10-line, 3-thread lace machine. The yarn used is 2-20 cot-



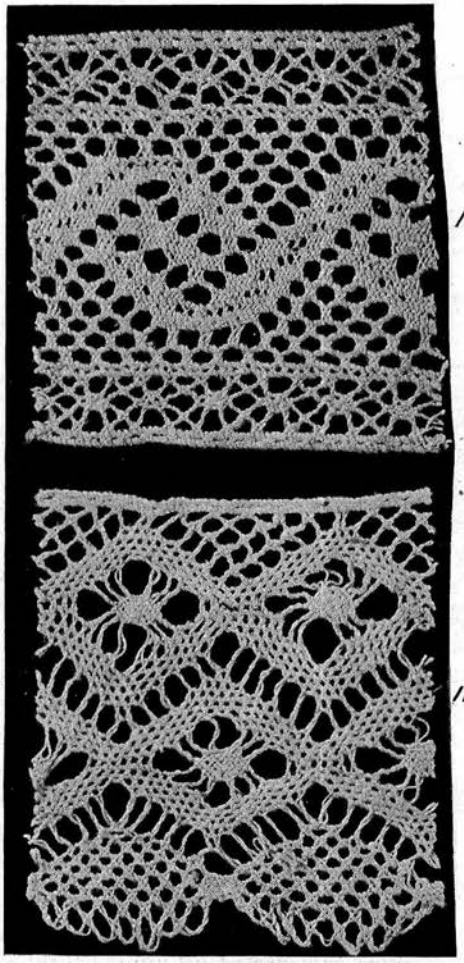
Figs. 113, 114, 115

ton, and the production about 6 yards per hour.

Fig. 115 shows a very tightly woven 3-thread lace, made on a 10-line machine from

fine yarn. The production of this pattern is about 2 yards per hour.

Fig. 116 shows a linen lace of characteristic design. It is made on a 30-line, 2-thread lace machine with 60 carriers, and the lace contains 60 threads of linen. This pattern requires a large machine, but is fairly fast-producing. Eight yards per hour is a



Figs. 116, 117

fair estimate of the production of one machine. Patterns of this kind are called insertions and are largely used as trimmings.

Fig. 117 is a 32-line, 2-thread lace, also made of linen thread. This pattern is somewhat looser woven than the preceding one and can be turned out on one machine at the rate of 10 yards per hour.

Fig. 118 is a cotton 2-thread lace of fine texture. It is made on a 24-line, 2-thread lace machine. The production is 4 yards per hour. The characteristic feature of this design is the zigzag figure which is accentuated by a heavier thread forming the border thereof.

Fig. 119 shows an eight line, 4-thread lace machine, consisting of eight sectional courses. The engraving shows the machine with part of the carriers removed in order to show the carrier courses more clearly. It will be noted that each of the sectional courses consists of three race-ways in such a way that each sectional course will produce a president braid, when the switches are closed. This machine is of the table driven type. The clutch gear shown in the rear of the machine engages with the table driving gear in the same manner as has been described in connection with plain braiders.

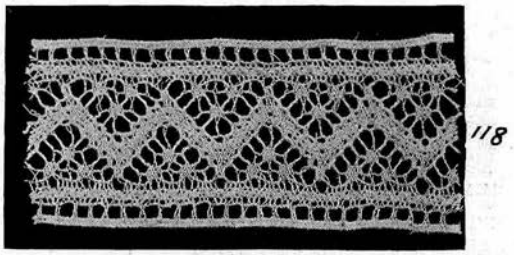


Fig. 118

A special feature of these lace braiders is the crown beater, which is so arranged that its prongs have a radial movement towards the braid former as the common centre. On account of the zigzag movements and crossings of the threads, it is necessary that a device of this kind be employed to cooperate with the selvage needles and assist in the braid forming operation. On machines of this kind, the power for driving the crown beaters is generally obtained through an auxiliary shaft in the rear of the machine, as is clearly shown in the engraving. The two change gears, which are shown disconnected in the cut, are in mesh with each other when in operative position. By changing these gears the speed of the crown beater can be regulated.

Another feature of these machines is the

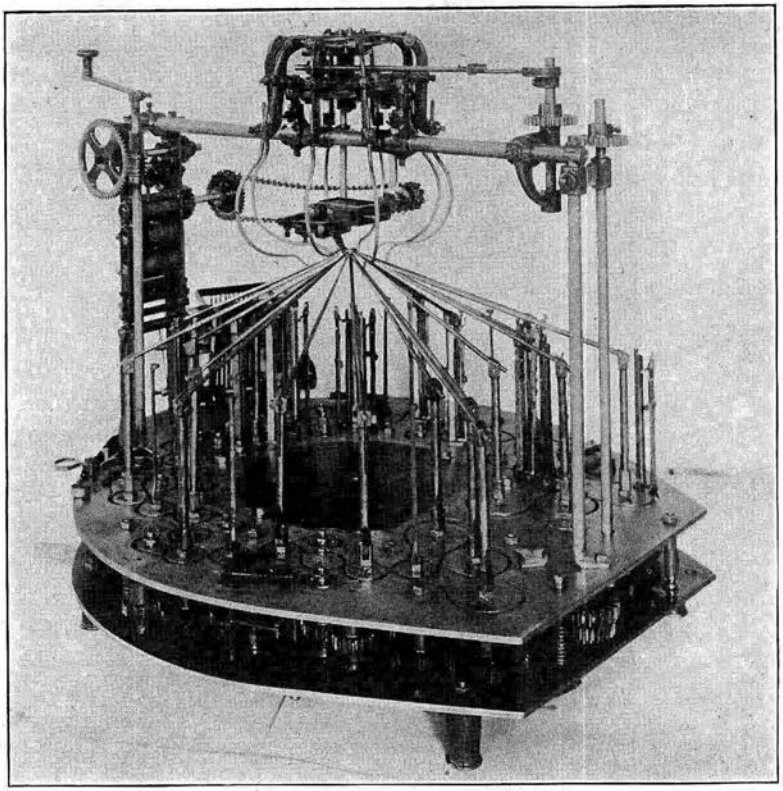
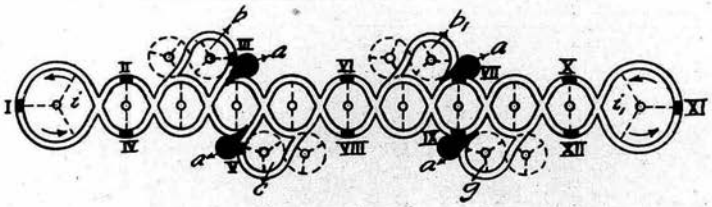


Fig. 119

auxiliary take-up. This is driven by the main take-up roller stand by means of a sprocket chain and consists of two corrugated brass rollers, which are placed immediately above the braid former. This take-up is necessary because the tensile strength of most of the lace fabrics that are made on machines of this kind would not be sufficient to stand the strain of the long pull from the main take-up roller stand to the braid former. By using the auxiliary take-up the part that is under tension is reduced to a few inches and the lace fabric is practically slack between the auxiliary and main take-ups. The latter is used only to convey the lace to the receiving cans.

Fig. 120 is a view of a 4-thread lace machine of three lines. The general construction of this diagram corresponds with the construction of the 8-line machine shown in Fig. 119. It will be noticed that all the gears with the exception of the two end gears and the sidetrack gears have two horns. The end gears or terminals (i and i), are provided with three horns. The sidetrack gears, b, c, g and b, have also three horns, but they are placed so closely to the adjoining 2-horn gears, together with which they form a compound race-circle, that the combined number of horns is three. It will thus be seen that the combined number of horns in the sections comprising the first, second and third race-circles is eight in each section and that four carriers will be accommodated by each section of three gears. The twelve carriers of a 3-line, 4-thread lace machine are shown in their respective positions and are numbered I, II, III, etc., consecutively. By projecting the position of these carriers, we develop a diagram of the resulting fabric in which the Roman figures show the location of the carriers corresponding to the plan view of the machine at the sectional line, a.

If we refer to the arrow marks and assume that the gears are all turned in the di-



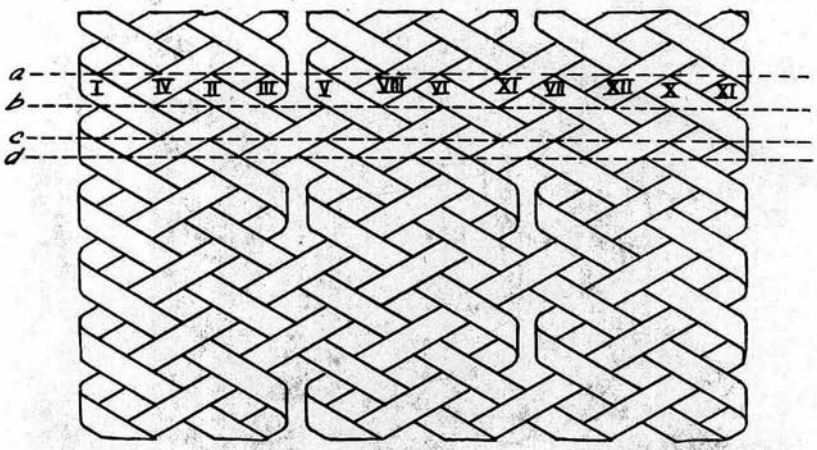


Fig. 120

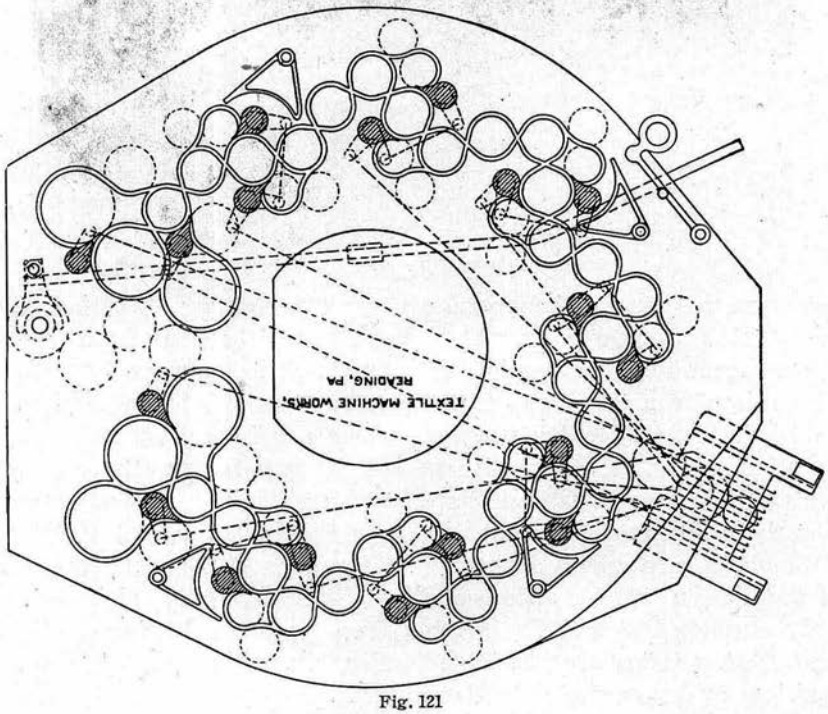


Fig. 121

rection of these marks for a space corresponding to that from one horn to the next, then the resulting location of the carriers will be as shown at sectional line, b, of Fig. 120.

Another movement of the carriers for the

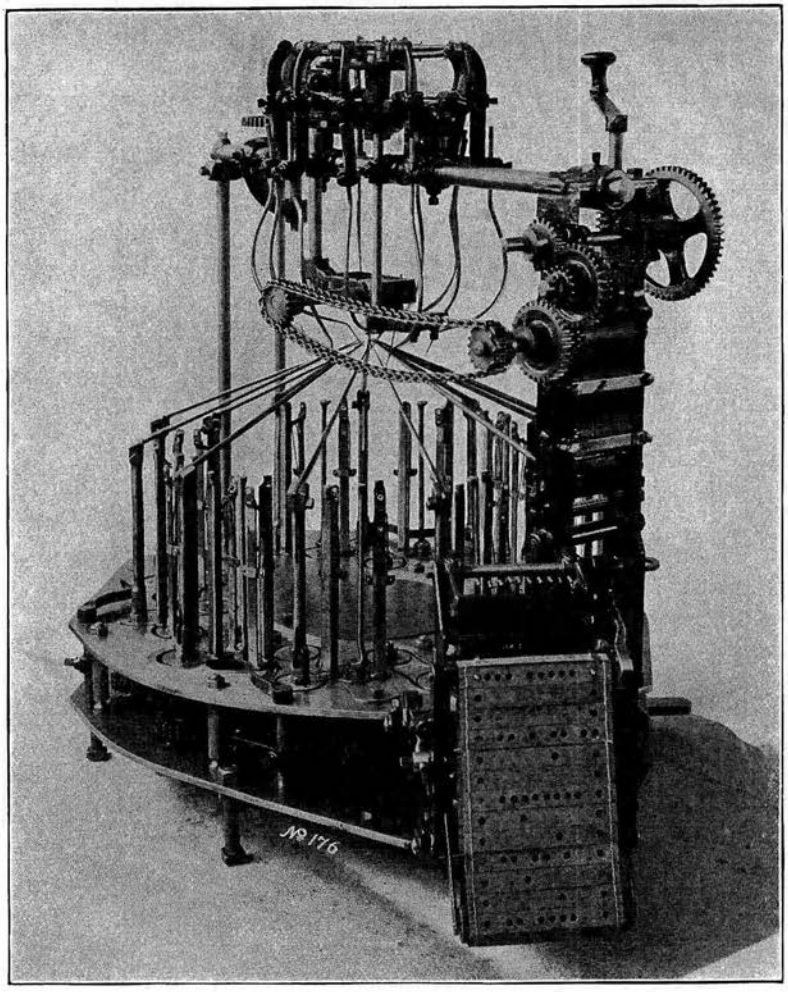


Fig. 122

space of one horn results in the position shown at sectional line, c, etc. It will be noticed that each group of four carriers remains on its sectional course as long as the switches, a, remain closed. In the position shown at sectional line, a, the switches shown nearest to the carriers III and V are closed, while the switches nearest to the carriers VII and IX are open. Resulting from this constellation of the switches a crossing of the carriers VII and IX occurs at the moment these switches are passed and these two carriers exchange their positions in the two adjoining sectional courses. As soon as carriers, VII and IX, have passed the switches, a, they are closed again by the action of the jacquard mechanism, as will be seen by referring to sectional lines, b, c and d. It will be clear from this diagram that two switches always have to open at the same time to let two carriers pass and exchange their position and that each opening of the switches results in a crossing of two carriers between two adjoining sections.

Referring again to Fig. 119, it will be observed that the general arrangement of the race-circles of the eight sectional courses corresponds to that in the diagram shown in Fig. 120. The plain 3-horn terminals shown in the diagram are the centre terminals shown on the photograph, whereas the two side-track terminals shown on both the inside and the outside of the main race circles are used for producing loop edges, as shown

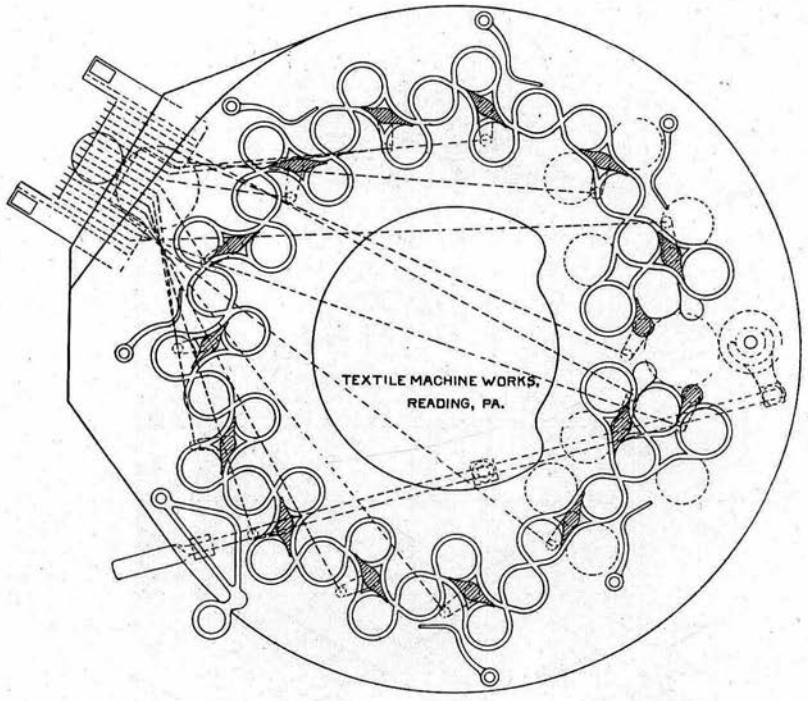


Fig. 123

on the patterns at Figs. 105, 107 and 109 in the preceding article.

In Fig. 121 a line cut shows the construction of the 8-line, 4-thread lace machine as built by the Textile Machine Works and illustrates the arrangement of the gearing. This line cut corresponds exactly with the machine shown at Fig. 119. The position of the switches and their connection to the jacquard mechanism shown in the diagram is clearly indicated by this cut. The dotted lines showing the switch connections show that all the switches which regulate the passage of carriers from one section to the next are connected in pairs so that they always have to operate together. The end switches however, that govern the passing of the carriers over the side-track terminals for the purpose of producing loop edges are connected independently.

Fig. 122 is a 10-line, 2-thread lace machine and shows more clearly some of the essential features of this class of braiders; namely, the jacquard mechanism in front, the auxiliary take-up and the crown beater attachment.

The 2-thread lace machines are the most important sub-class of lace braiders because of the fact that only two carriers are used for each line. The fabric resulting from this construction is more nearly like the real or hand made lace than the fabric made on the machines previously described. The 2-thread lace machines are also smaller in diameter for a given number of lines than the 4-thread, and the arrangement of the gears allows of a more compact machine.

In Fig. 123 a plan view showing the gearing of a 12-line, 2-thread lace machine is shown. The general arrangement of this corresponds with the 10-line machine shown in Fig. 122. Each sectional course or line consists of three gears. The switch operated connections between each two adjoining lines are so placed that the carriers pass from the last gear of one section to the first gear of the adjoining section, two carriers always passing at the same time and exchanging their positions. The manner in which this is done will be more clearly illustrated by referring to the diagram in Fig. 124.

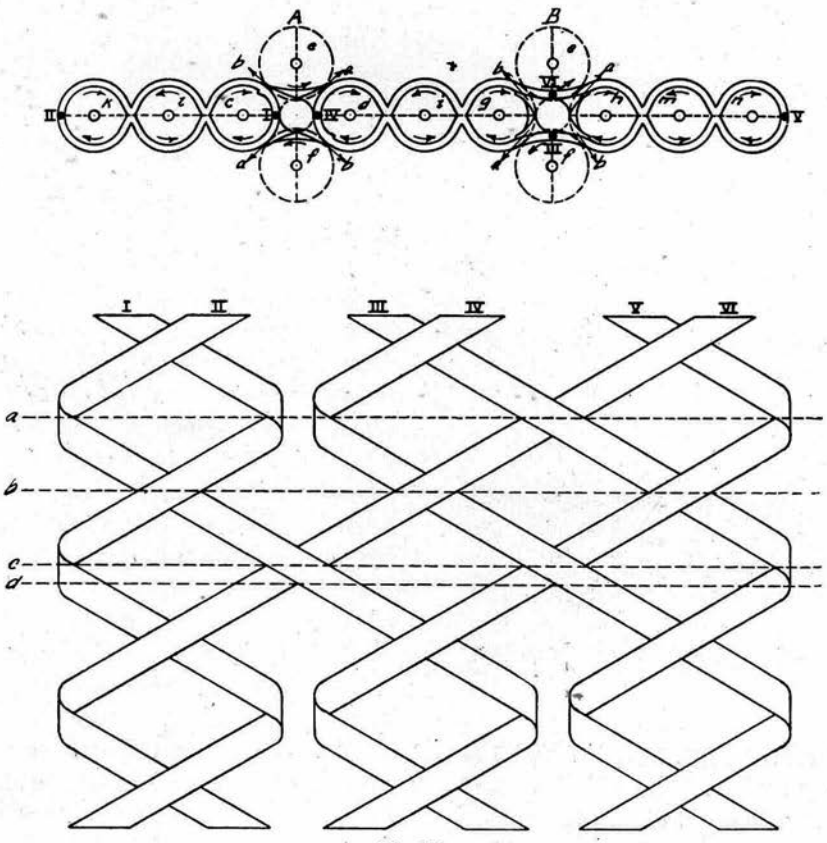


Fig. 124

In this diagram a 3-line, 2-thread lace machine is shown and, as is customary in views of this kind, the gears are shown arranged in a straight line. All the gears are 2-horn and each section consists of three gears. I to VI show the location of the carriers as corresponding with the sectional line, a, in the projected diagram of the fabric. The switches at (a) between carriers, I and IV, are closed and the carriers return therefore upon their own courses. The switches at (a) nearest to carriers, III and VI, are open and, therefore, these two carriers exchange their places in the two adjoining courses and cross over from one course to the other, as is shown at sectional line (a). The sectional line (b) represents the position of the carriers after all the gears have made half of a revolution and the carriers have traveled the distance from one horn to the next. At the sectional line (c) a crossing of the carriers from section one to section two and from section two to section three is shown which indicates that all four switches must be open.

In the same manner the most complicated designs may be analyzed and the working of the switches determined. The punching of the cards is done in a manner very similar to that described in connection with radium or bi-circle machines.

LACE MACHINES.

In the preceding articles on this subject a number of lace patterns have been illustrated and the four, three and two thread lace machines have been described. These laces were principally of the cotton and linen lace class used as trimmings for white goods, such as undergarments and lingerie. The same patterns are also quite frequently

made for dress trimmings and either natural or artificial silk is employed as the preferred material.

Fig. 125 shows a lace braid made on a ten line, two thread lace machine. The material is artificial silk, and the pattern a very simple one.

Fig. 126 is a dress trimming made on a twelve line, two thread lace machine. The wheel pattern which forms a characteristic of this design is produced by two gimps braided into the fabric in such a way as to form circles.

Fig. 125

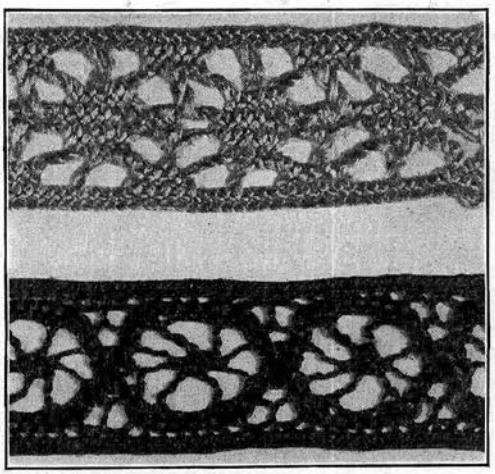


Fig. 126

Fig. 127 illustrates a sixteen line, two thread lace machine of the so-called two plate type. This style of lace braiders is particularly adapted for making dress trimming braids, such as have been illustrated in the preceding patterns. Each section of this machine consists of two plates only, and it will be noticed that each of the bars of the resulting fabric will consist of a soutache, as the carriers, while confined on the sectional courses, move in a figure eight. Each of these sectional courses consists of one circular portion and one circular portion with horseshoe extension. The advantage of this arrangement for dress trimming braids is that it prevents putting twist into the individual threads. The right and left rotations of the carriers exactly balance each other, whereas on the three plate system of machines the rotation of the carriers on each section is out of balance as to right and left twist, because there are three gears, of which two run in the same and only one in the opposite direction. In patterns using gimp or other heavy materials, this was a disturbing factor which led to the construction of this type of machines.

Fig. 127 shows the entire run of the machine as nearly circular as the horseshoe extensions will permit. This construction was chosen in preference to the compact zigzag arrangement, shown in connection with Figs. 119, 121 and 123, because it was found that machines with this arrangement of the course could run faster on account of the reduced up-and-down movement of the tension weights in the carriers, there being less slack thread to take care of. The only disadvantage of this arrangement is the increased size of the machine, which is about fifteen to twenty per cent. larger than the same machine with the compact zigzag course. The larger sizes, such as twenty and twenty-four line machines, are for that reason built with the compact zigzag courses, but otherwise on the same principle.

Fig. 128 is a lace braid made on a sixteen line, two thread lace machine. The irregular scalloped edge of the braid is obtained by the use of a device known as a revolving mandrel the operation of which is as follows: The two edges of the braid are connected by means of a soutache connecting section, changing the whole from a flat to a tubular fabric. This tubular fabric closely hugs a steel mandrel, the base of which extends through the bottom plate of the machine and which is adapted to be rotated. This rotating is done by means of intermittent cams to produce the differently curved edges of the finished braid. The soutache connections are afterwards cut away and the short ends of fibers are removed by brushing.

Fig. 129 is a bi-circle braider having one of these soutache connections built in. It will be clear from this illustration how, by means of this auxiliary run, the edges of the

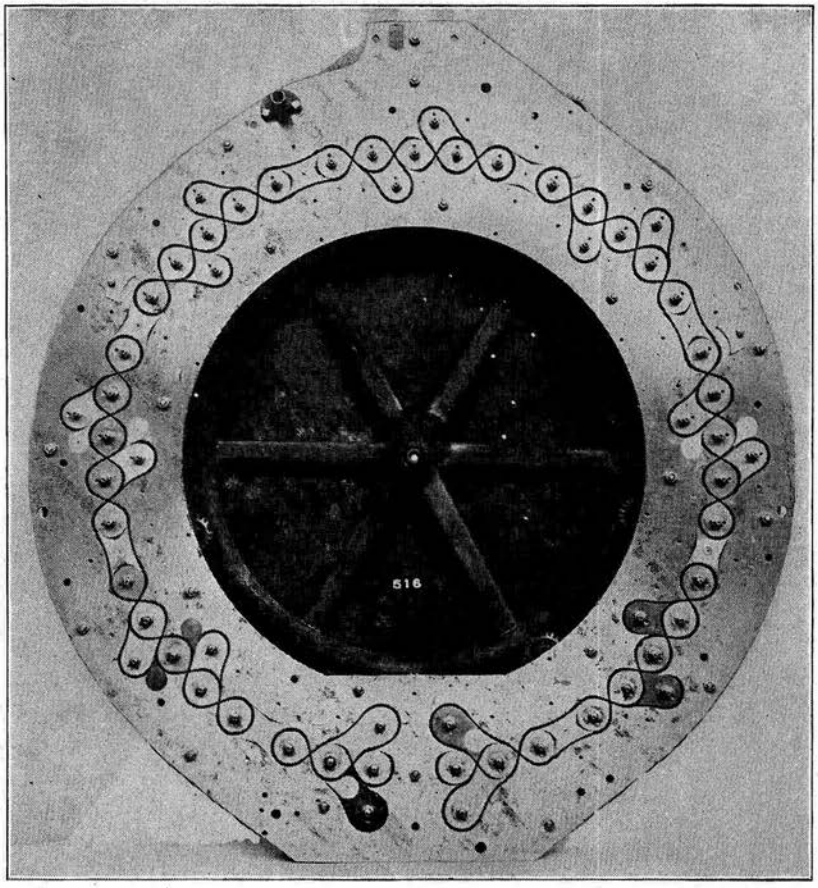


Fig. 127

flat braid are united and a tubular construction of the braid is obtained, all for the purpose of forming the braid around a mandrel, which by rotation will give the braid the desired curved contour.

SINGLE THREAD LACE MACHINES.

As will be seen from the foregoing illustrations of the various braided laces and the descriptions of the machines upon which they are produced, a very large and almost unlimited scope of pattern possibilities can be obtained. Yet this class of machines has one limitation, making it impossible to copy all the patterns of hand-made lace. This limitation consists in the necessity of all the carriers moving all the time. This limitation has been removed in the single thread lace machines, which are highly complicated machines provided with means for causing any of the carriers to stand still and remain disengaged from the propelling action of the gears for such a length of time as may be determined by the jacquard pattern mechanism.

Figs. 130, 131, 132 and 133 illustrate four patterns made on single thread lace machines. These represent perfect imitations of hand-made laces, and they are generally known among the trade as hand-made laces. This class of laces may safely be called the acme of perfection in the art of machine braiding.

The operation of the machines producing these laces is, in fact, an exact duplicate of the hand operation as far as the manipula-

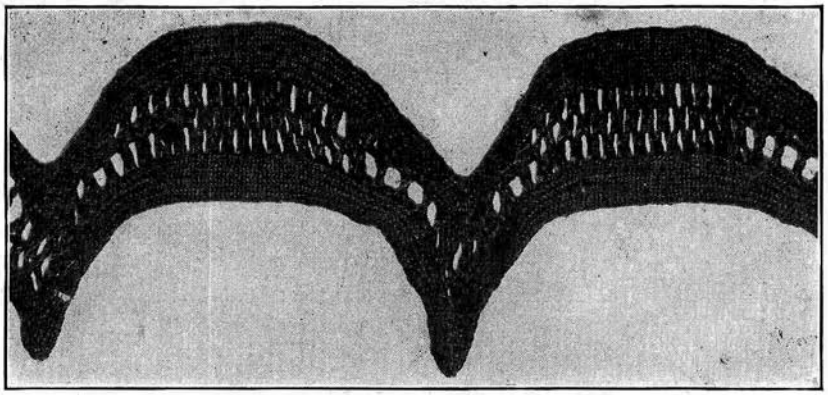


Fig. 128

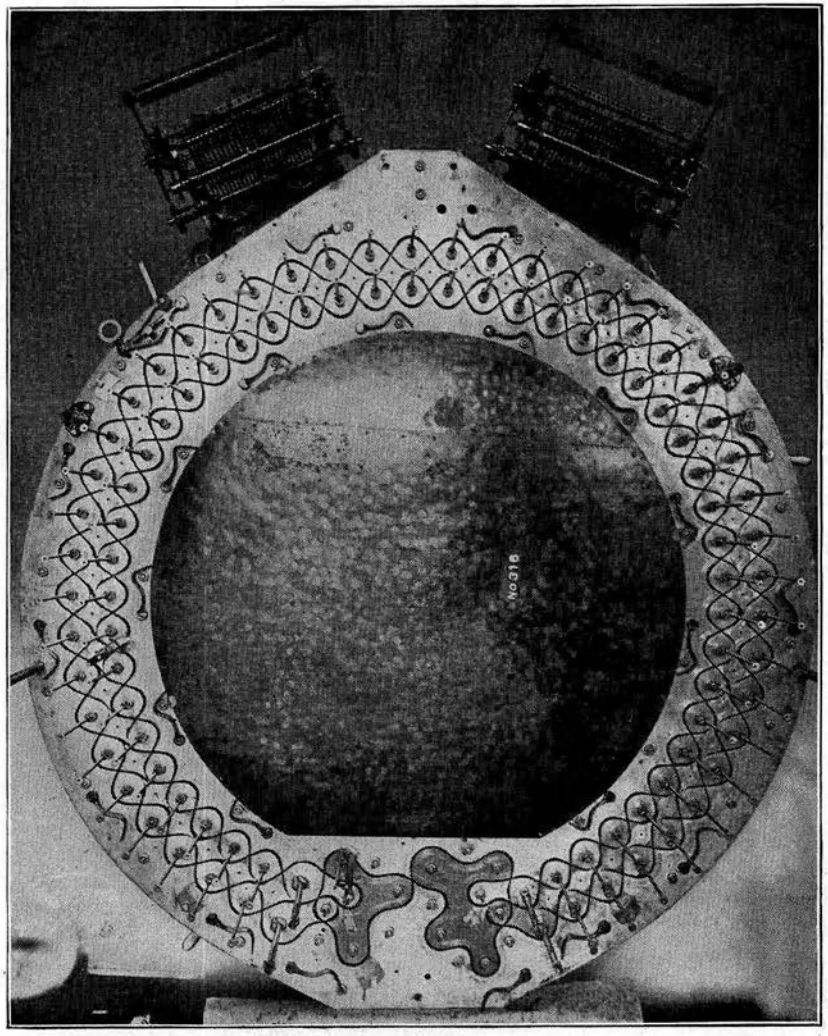
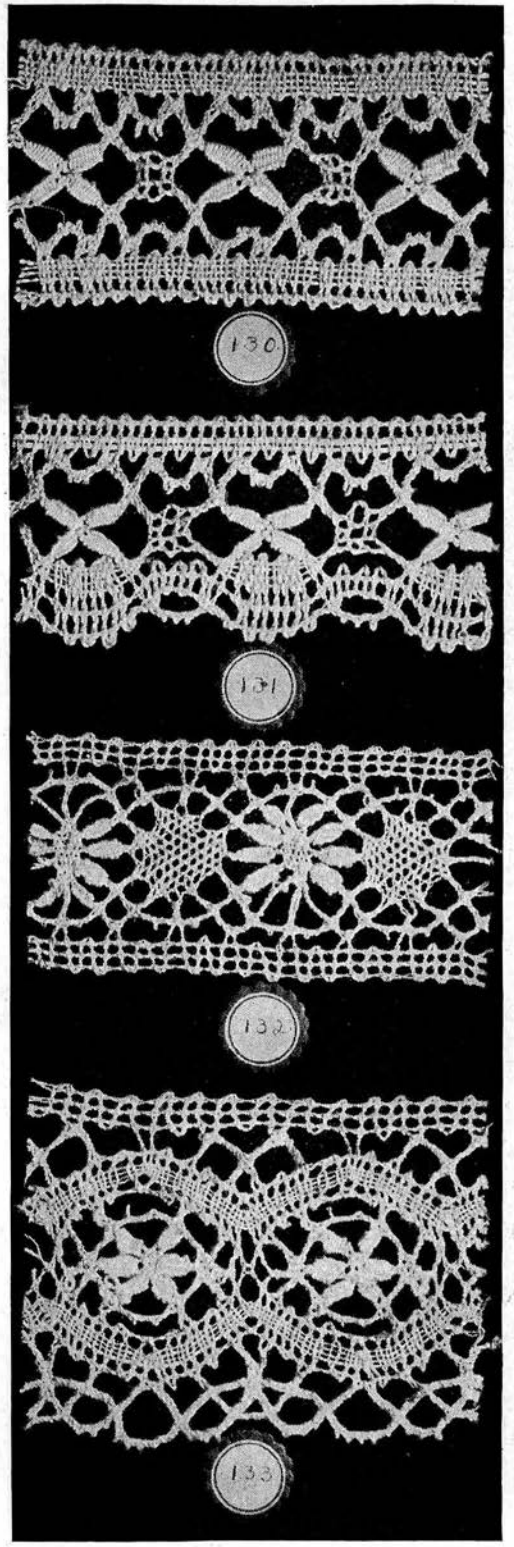
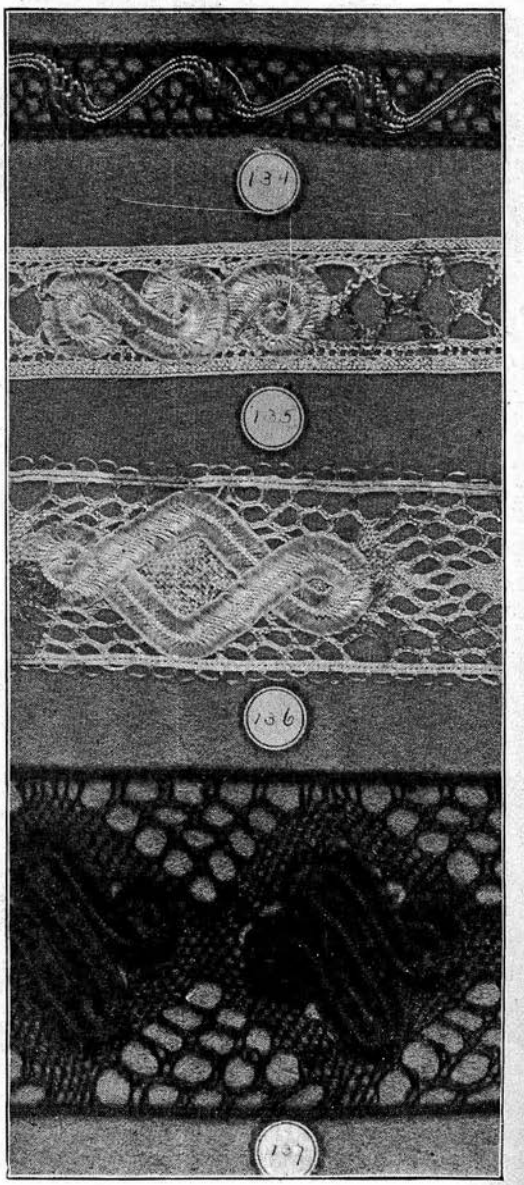


Fig. 129

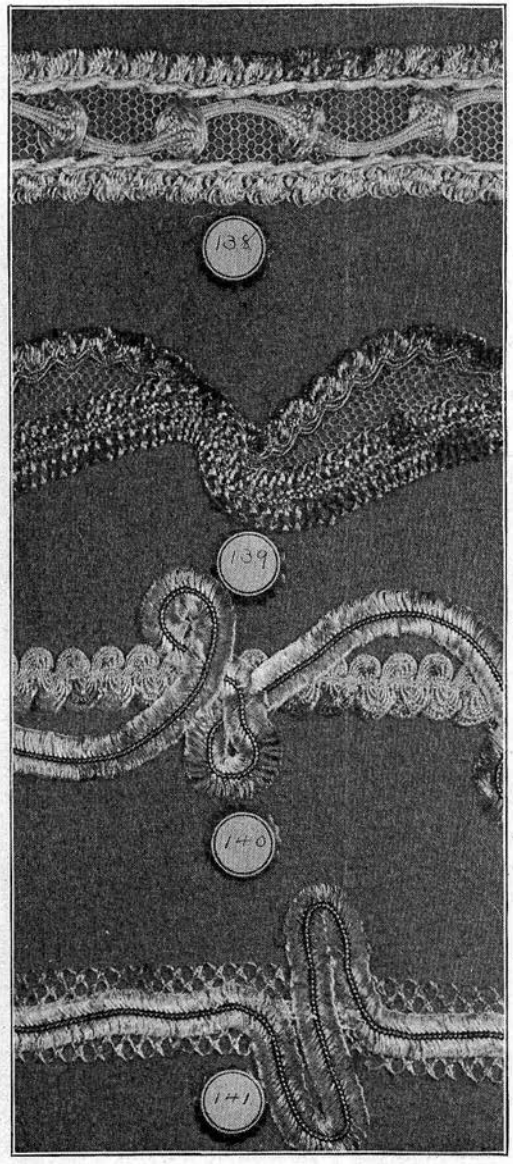


Figs. 130, 131, 132, 133

tion of the spools and the crossing of the threads is concerned. Instead of the cushion with pins, which the makers of hand-made lace use to determine the pattern, the jacquard mechanism is utilized to govern the travel of the bobbin carriers. At the point of braiding, sinkers or beaters, operating along similar lines as the crown beaters illustrated in Fig. 28 of a preceding article, assist the tension of the individual threads



Figs. 134, 135, 136, 137

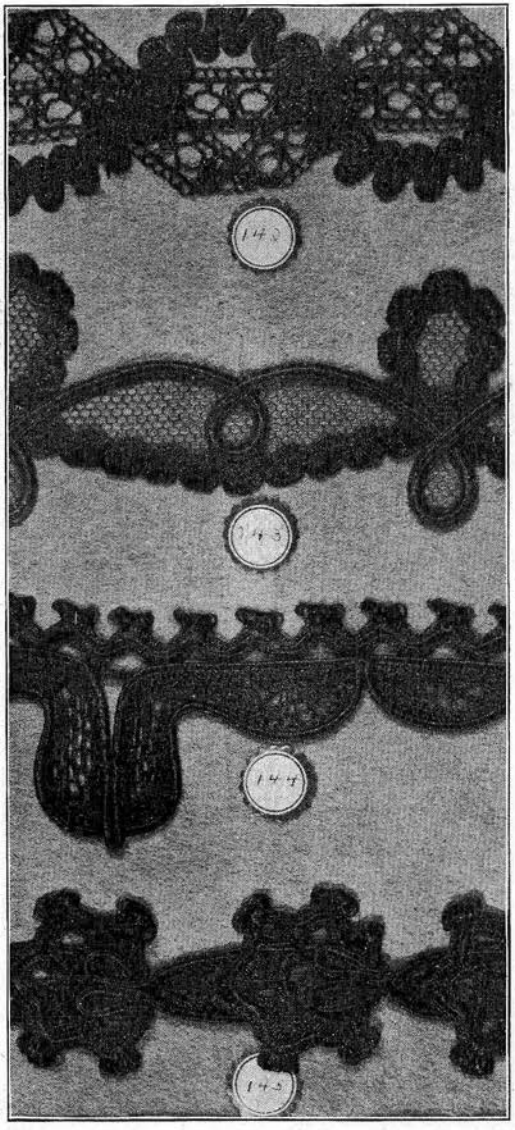


Figs. 138, 139, 140, 141

in giving firmness to the fabric. On account of the intermittent movement of the bobbin carriers, the production of these machines is usually small and ranges from 12 to 40 yards per day, according to the pattern. On account of this circumstance and of the fact, resulting from it, that a considerable number of these machines are required in order to make these laces on a commercial scale, this industry has so far been restricted to a few large concerns operating a great many machines, and up to this writing laces of this character are not manufactured in the United States.

LACE AND BRAID TRIMMINGS.

In the preceding articles I have described a great many braid products from the simplest to the most elaborate patterns and have shown how they are made. I will now illustrate a few trimmings composed chiefly of braids and advanced beyond the stage of



Figs. 142, 143, 144, 145

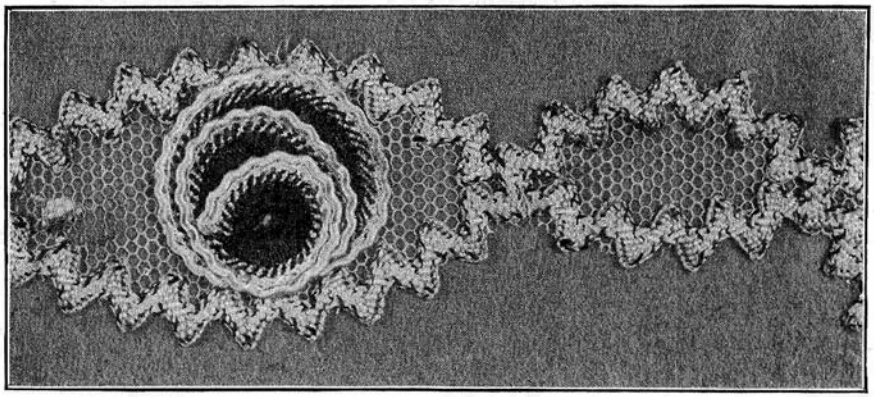


Fig. 146

a single braided fabric by sewing together several braids or by sewing braids as ornaments on strips of netting or veiling.

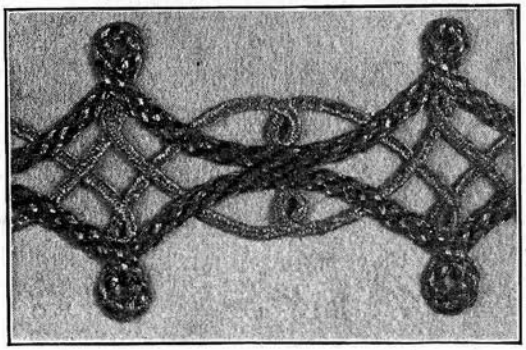


Fig. 147

Fig. 134 shows an eight line, three thread lace made of black artificial silk with a serpentine black and white figure sewed on the lace background. This black and white braid consists of a small tubular made from artificial silk, and the wide portions thereof are produced by loose braiding resulting from the use of an intermittent take-up on the tubular braiding machine.

Fig. 135 shows a white trimming, the foundation of which is an artificial silk lace made on an eight line, four thread lace machine. The figure sewed on at regular intervals is made from white artificial silk featheredge braid.

Fig. 136 shows a twelve line white artificial silk lace made on a four thread lace machine. The figure design consists of the same featheredge braid shown in the preceding illustration.

Fig. 137 is a sixteen line lace made on a four thread lace machine from black artificial silk. The figure design consists also of a featheredge braid made from the same material.

Fig. 138 shows a trimming composed of two featheredge braids sewed to the edge of a strip of netting. The centre figure consists of a tightly braided silk tubular braid with loosely braided portions interposed. These loosely braided portions are compressed lengthwise and form the circular or tulip effect shown in this trimming.

Fig. 139 shows a trimming composed of a three line rickrack braid with featheredge on one side sewed on a piece of netting cut out in irregular shape, the featheredge of the braid projecting beyond the edge of the netting. The opposite edge of the trimming shows a lace braid made on an eight line,

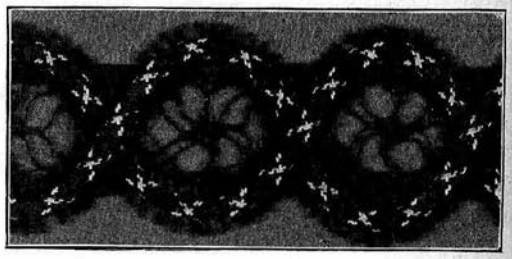


Fig. 148

four thread lace machine and illustrates how this braid is adapted to be folded edgewise to form irregular lines.

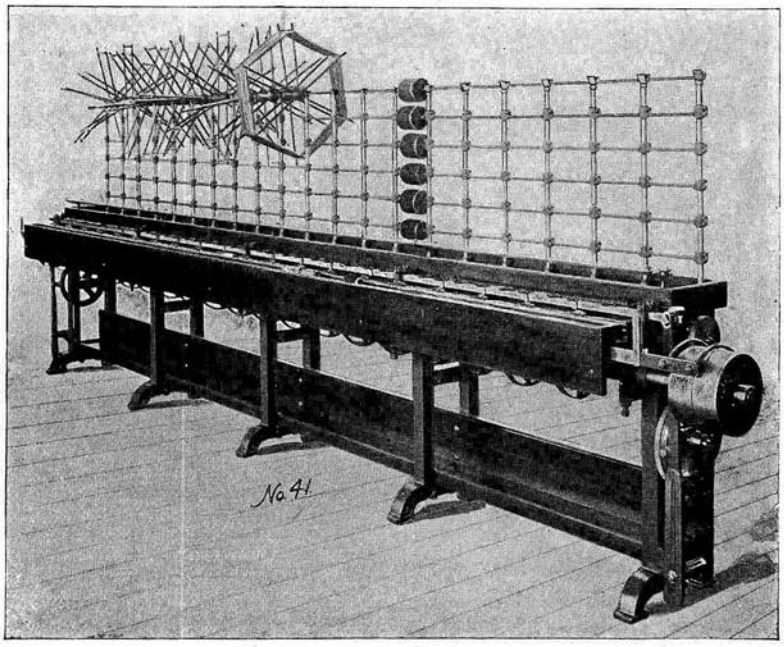


Fig. 149

Fig. 140 shows a waved braid of white artificial silk with a black and white featheredge braid sewed on forming a composite design.

Fig. 141 has as a background a lace braid made on an eight line, two thread lace machine with a black and white featheredge braid sewed on as shown.

Fig. 142 shows a very pretty trimming composed of two narrow two thread lace braids and black rick-rack braid, all three sewed together to form a design.

Figs. 143, 144 and 145 show three passamenterie-like trimmings. Fig. 143 is composed of a rick-rack braid with featheredge on one side, a president braid made from artificial silk with a heavy filling and netting to form the foundation for the trimming. Figs. 144 and 145 show how radically different effects can be produced by a combination of two braids. The lace braid and zigzag loop braid in both patterns are the same.

Fig. 146 shows a pretty effect produced by the use of netting, black and white rick-rack braid and a black and white stripe braid laid up to form a spiral figure.

Fig. 147 shows a tinsel trimming made from black and gold tubular braids and gold soutaches.

Fig. 148 shows a pretty effect obtained by two loop edge tubulars in black and white artificial silk, forming circular figures.

The foregoing illustrations show only a very limited number of designs, but they will give a good idea of the endless combinations possible in using braids as trimmings. The entire line of passamenterie and embroidery ornaments is practically built on braids worked up into ornaments.

In the foregoing articles I have only attempted to give a few illustrations of each class, and hope that I have succeeded in impressing the reader with the possibilities of the braid industry. Wherever ornamentation of a garment or other article of apparel is desired and in place, braids in some form or other will usually be found to be the most appropriate.

WINDING AND DOUBLING OF BRAIDER BOBBINS.

Inasmuch as properly wound spools are most essential in getting good results on braiding machines, I will briefly call attention to the winding and doubling machines illustrated by Figs. 149 and 150, and built by

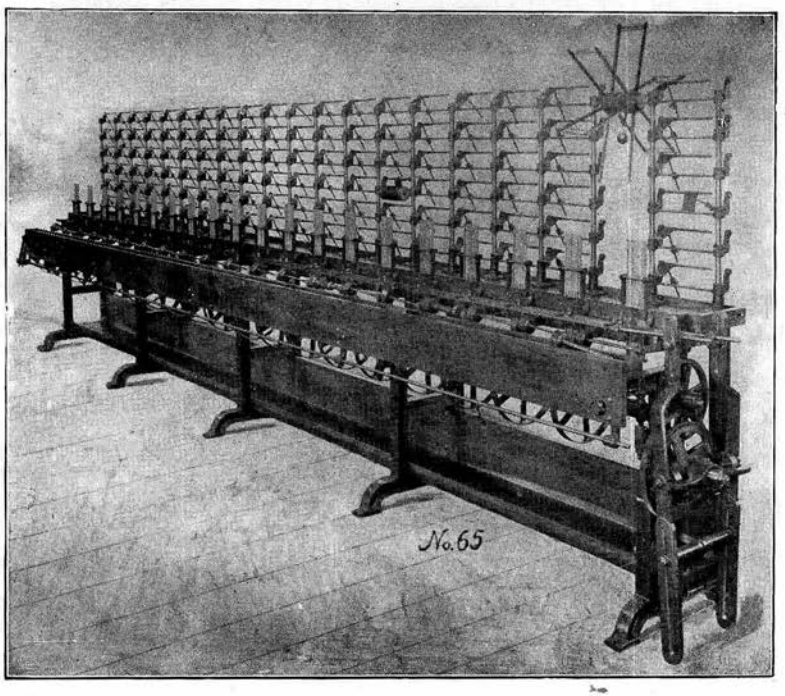


Fig. 150

the Textile Machine Works. The winder shown at Fig. 149 is made with iron frames connected by means of angle iron, the whole frame work being stiff and compact. The shaft runs in boxes which are vertically adjustable, thus securing perfect alignment. The pulleys are of iron, 10 inches in diameter and 1¼-inch face. The spindles revolve on these iron pulleys. They are made from tool steel turned from the solid and tempered at both ends. The heads are made of compressed leather washers held between iron flanges. The leather spindle heads running on iron pulleys give a perfect friction contact. The diameter of head and weight of spindle can be varied according to the size of the yarn to be spooled. The traverse guide is operated by a cam on one end of the machine. This cam is made with 1¼, 1½, 2 and 2½ inch throw, is accurately milled on a special machine and is absolutely true, the result of which is a perfectly wound spool. The length of the traverse can be adjusted by means of the lever which conveys the motion to the guide bar.

If desired, two sizes of spools can be made on the winder at the same time and on any of the spindles. In order to allow this, a second traverse bar is placed on the machine and a second lever on the cam. By changing the position of the fulcrum, the traverse of the two bars can be made to vary. The thread guides are mounted on a clamp which can be fastened either on the front or rear bar, while the distance of the eyes from the centre of the spindle remains the same. A stop motion is provided to stop the spindle when the spool is full. The swifts are made in the well known manner shown in the illustration. A trough for laying down the spindles and spools forms the top of the front board, and a shelf for empty spools serves as a base for the iron frames. This machine can be built with any desired number of spindles, the usual size being twenty spindles.

The doubler illustrated in Fig. 150 is practically the same machine as the winder illustrated in the preceding figure. The spindles are of the same general construction, but

are usually heavier in accordance with the work they have to do. These machines are arranged for doubling up to eight ends of silk or any other material. An automatic stop motion is provided which stops the spindle as soon as an end breaks or a spool runs out. This stop motion works very rapidly, and the broken end does not get any further than the thread guide before the spindle stops.

A brake with adjustable weights is provided to secure tension on the winding spools in the frame. To get more or less tension on the spools a sliding weight is fastened by means of a knurled set screw at a greater or less distance from the flat end of the lever pressing against the winding spool. The cam and double lever riding thereon are plainly shown on this cut. It is clear that two different lengths of traverse can be made on this machine also. The two levers are connected by a yoke arm, exerting a spring pressure against both levers and balancing them in such a way that when one goes in the other goes out, riding on opposite sides of the cam.